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ETUDE D'UNE COLLECTION DE STOMATOPODES DE L'AUSTRALIAN MUSEUM DE SYDNEY

Par R. SERENE,

Directeur p.i. de l'Institut Océanographique de l'Indochine.

(Plates I–III, Figures 1–33.)

La petite collection de Stomatopodes de l' " Australian Museum " de Sydney qui m'a été confiée pour étude rassemble 13 specimens que je rapporte aux espèces suivantes :

1 — P. 5.614 un mâle de 86 mm. *Squilla depressa* Miers.
2 — P. 6.785 une femelle de 49 mm., 5. *Squilla depressa* Miers.
3 — P.10.934 une femelle de 77 mm. *Squilla depressa* Miers.
4 — P. 4.843 une femelle de 64 mm. *Lysiosquilla multifasciata* Wood-Mason.
5 — P. 6.788 une femelle de 85 mm. *Lysiosquilla acanthocarpus* Miers.
6 — P.10.372 une mâle de 20 mm. *Gonodactylus spinosocarinatus* Fukuda.
7 — P.10.372 une femelle de 18 mm. *Gonodactylus spinosocarinatus* Fukuda.
8 — P.10.805 un mâle de 22 mm., 50. *Gonodactylus tweediei*, sp. nov.
9 — P.10.340 un mâle de 24 mm. *Gonodactylus tweediei*, sp. nov.
10 — P.10.070 une femelle de 22 mm., 5. *Gonodactylus tweediei*, sp. nov.
11 — P. 5.273 une femelle de 24 mm., 5. *Gonodactylus tweediei*, sp. nov.
12 — P. 5.273 une femelle de 26 mm., 5. *Gonodactylus tweediei*, sp. nov.
13 — P. 5.273 une femelle de 21 mm. *Gonodactylus tweediei*, sp. nov.

Son intérêt tient à ce que 1°—*S. depressa* connue par le seul specimen type de Miers n'a jamais été décrite, 2°—On ne connait guère qu'une trentaine de specimen de *L. multifasciata* et une vingtaine de *L. acanthocarpus*, 3°—Des deux espèces de *Gonodactylus*, l'une *G. spinosocarinatus* est très rare et n'a été signalée que deux fois, l'autre est nouvelle.

La description de *S. depressa* exige l'étude comparée avec les deux espèces voisines, elles-mêmes mal connues, *S. latreillii* et *S. microphthalma*, pour préciser la situation exacte de l'espèce. Les specimens de la présente collection de *Lysiosquilla multifasciata*, *L. acanthocarpus* et *Gonodactylus spinosocarinatus* appartenant à des espèces que j'ai longuement étudiées dans un récent travail à paraitre sur les Stomatopodes d'Indochine ne sont examinés que rapidement. La description de la nouvelle espèce *Gonodactylus tweediei* est accompagnée de remarques sur les deux espèces voisines *G. trigibbosus* et *G. folini* qui précisent sa situation.

Je remercie Mr. F. A. McNeill et Miss E. C. Pope de l'Australian Museum qui ont pensé à me faire confier l'étude de cette collection. Mr. Tweedie, Directeur du Raffles Museum de Singapour, qui l'avait examinée, a eu la générosité de se dessaisir en ma faveur d'un travail dont il savait tout l'intérêt comme le montre ses notes qui m'ont été communiquées; je lui témoigne ici toute ma reconnaissance et suis heureux de pouvoir lui dédier la nouvelle espèce décrite ici. Je remercie enfin le Dr. A. B. Walkom, Directeur de l'Australian Museum pour son amabilité à présenter aux " Records of the Australian Museum " la publication de ce travail qui a été effectué à l'Institut Océanographique de l'Indochine (Nhatrang, Viêtnam) qui possède une riche collection de Stomatopodes de la Région Indo-Pacifique.

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Squilla depressa Miers.

1880—*Chloridella microphthalma* (depressa) Miers, p. 14, pl. II, fig. 1–4.

1882—*Chloridella microphthalma*, Haswell, p. 207.

Diagnose.—

Yeux.—Les pédoncules oculaires, un peu moins de deux fois plus longs que larges, atteignent le premier tiers de la longueur de l'article basal du pédoncule antennulaire et à peu près le milieu du premier article de l'endopodite antennaire. La cornée noire divisée en deux lobes est très petite et n'occupe qu'une partie de l'extrémité des pédoncules oculaires; elle a seulement environ la moitié de la largeur de la partie médiane fortement élargie du pédoncule; les bords internes du pédoncule non juxtaposés sont légèrement renflés dans la partie médiane et les bords externes le sont davantage. Les prolongements dorsaux du segment ophthalmique sont très peu développés en une courte écaille médiane à bord antérieur arrondi.

Antennules et antennes.—La longueur des antennules se trouve environ quatre fois dans la longueur totale du corps; le pédoncule antennulaire est un peu plus long que la carapace sans rostre et un peu plus court que la carapace avec rostre. Les antennes sont plus courtes que les antennules. Les deux articles basaux de l'antenne sont longs et leur extrémité antérieure atteint le niveau de l'extrémité antérieure des yeux, leur longueur est presqu'égale à celle de la pale (écaille) antennaire (exopodite). Le pédoncule de l'endopodite antennaire légèrement plus long que la pale (écaille) antennaire égale la largeur antérieure de la carapace. Le palpe mandibulaire est composé de trois segments.

Rostre.—Le rostre lisse est à la base presque deux fois plus large que sa longueur médiane (2 mm. 5/1 mm, 5, dans P. 10.934 femelle de 77 mm.). De forme générale triangulaire à angles arrondis; ses bords latéraux d'abord faiblement inclinés convergent rapidement vers l'apex qui est très arrondi.

Carapace.—La carapace lisse est beaucoup plus large en arrière qu'en avant. Sa plus grande largeur, en avant des angles latéro postérieurs, est à peu près égale à sa longueur médiane rostre exclus et le double de sa plus petite largeur au niveau des épines antéro latérales; ses bords antérieurs sont presque transverses, les parties extérieures entre le rostre et les angles antéro latéraux n'étant que très légèrement inclinées en arrière; l'épine de l'angle antéro latéral assez faible est dirigée en avant. Les angles postéro latéraux sont largement arrondis et le bord postérieur est peu échancré et très légèrement concave dans la partie médiane (gastrique). Les sillons gastriques marqués jusqu'au sillon cervical, lui même peu accentué, sont encore indiqués mais faiblement sur le bord postérieur de la carapace. La carène marginale invisible antérieurement se confond au delà du sillon cervical avec le bord latéro postérieur et s'infléchit de chaque côté vers l'intérieur en une carène courbe qui remonte vers l'avant. Cette carène courte qui délimite surtout vers l'extérieur un sillon profond, s'arrête à moitié distance environ avant le sillon cervical; il n'y a pas de trace de carène latérale; on note un tubercule médian sur le bord postérieur et un autre dans l'axe médian, à la limite du premier tiers antérieur; tous deux sont très faibles.

Pattes ravisseuses.—Le dactyle porte quatre dents y compris la terminale. Le dactyle fortement convexe distalement ne porte pas sur son bord externe proximal d'encoche creuse nette mais l'angle avant l'articulation avec le propodus est cependant bien marqué. Le propodus a trois épines mobiles proximales, la seconde étant la plus courte, et une série de fines pectinations le long du bord sinueux opposé au dactyle. La carène dorsale du carpus courte et entière se termine brusquement avant d'atteindre le bord distal. Le merus est long et son extrémité distale dépasse nettement la cornée des yeux atteignant le deuxième article de l'endopodite antennaire.

Segments.—Les trois derniers segments thoraciques portent des carènes intermédiaires et des latérales qui se confondent avec le bord latéral; pas de carène submédiane. Le cinquième segment thoracique très court est prolongé latéralement par une épine courte dirigée transversalement. Les bords latéraux du sixième et septième segment sont en avant fortement retournés et arrondis tronqués et aussi très arrondis en arrière; ceux du huitième sont en avant moins tronqués et en angle arrondi, très effacés en arrière avec une légère encoche en creux dans la partie médiane. Les pattes des trois derniers segments thoraciques ont leur endopodite en forme de lame membraneuse ovalaire et allongée, comme dans toutes les espèces du groupe *S. latreillii*.

Les cinq premiers segments abdominaux portent trois paires de carènes longitudinales : les submédianes sont absentes, les intermédiaires faiblement marquées sauf sur le quatrième et surtout le cinquième, les latérales et marginales nettes sur tous. Le sixième segment porte des carènes submédianes, intermédiaires et latérales, toutes terminées en épines. Le dimorphisme sexuel modifie le relief de ce segment chez les grands mâles. La formule spinale est :

Carènes.	*Segments Abdominaux.*
Submédiane	6
Intermédiaire	5, 6
Latérales	5, 6
Marginales	(1) 2, 3, 4, 5.

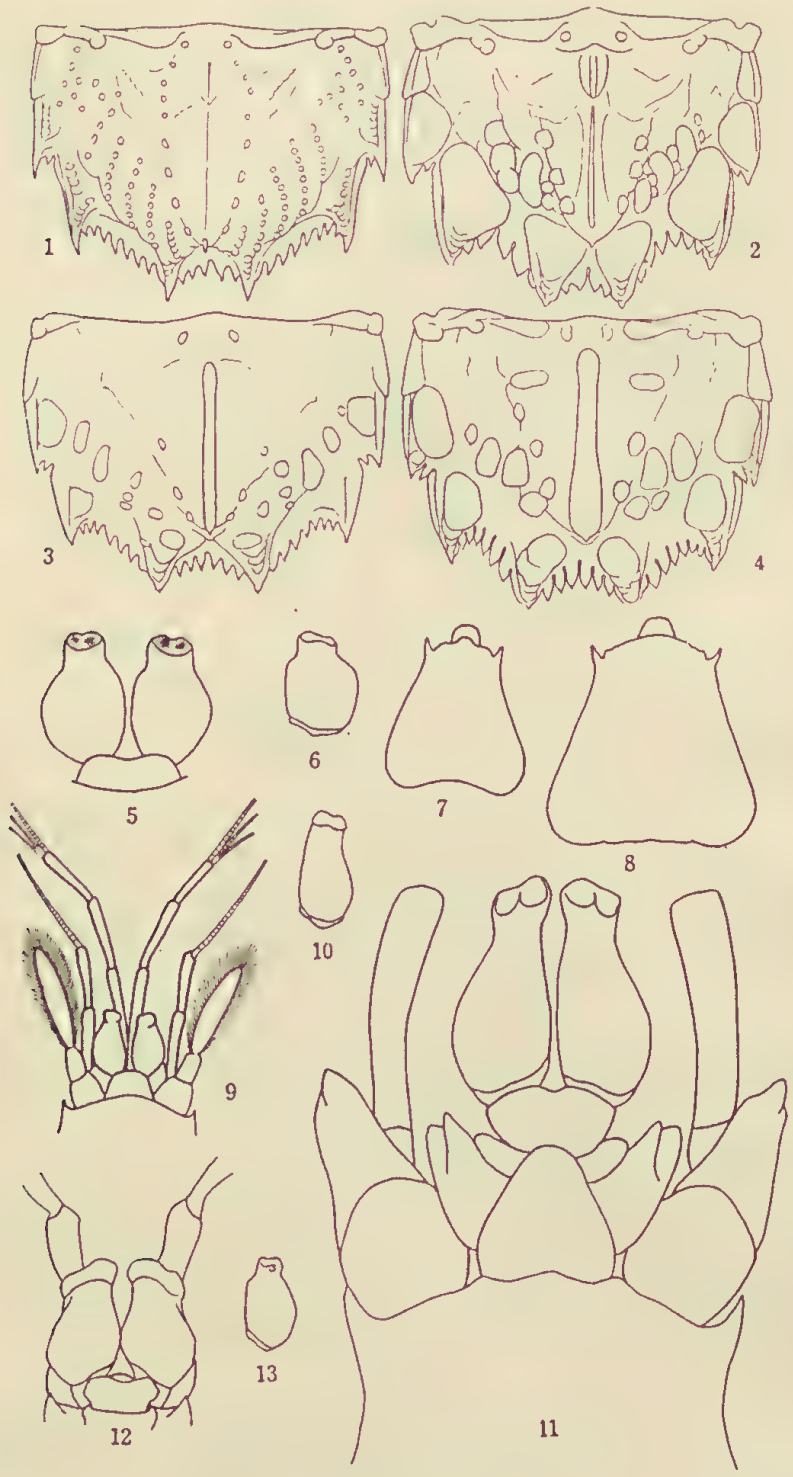
On trouve sur les segments trois, quatre et cinq, le même petit tubercule médian que sur *S. latreillii* mais très peu visible.

Telson.—Le telson plus large que long est fortement convexe dorsalement. La carène médiane très distincte est terminée par une épine; de chaque côté de la carène médiane se trouve une rangée de tubercules plus ou moins réguliers ou développés (de trois à quatre d'ordinaire), les deux rangées convergent postérieurement et s'unissent en un petit tubercule immédiatement au-dessous de la fin de la carène médiane. A l'extérieur et en ligne oblique entre l'extrémité de la carène médiane et la dent latérale un certain nombre (4 à 5) petits tubercules plus ou moins développés nets ou obscurs. La disposition générale de ces tubercules et leur développement varient avec les individus et en fonction de l'âge et du sexe, comme le montrera l'étude du dimorphisme sexuel.

Les six principales dents du bord du telson sont aigues et courtes; et il y a un petit lobe prélatéral. La paire de dents submédianes est pourvue de petites épines terminales mobiles. Les bords externes des dents intermédiaires et latérales sont denticulés. Il y a trois paires de denticles submédianes (ceux de la paire la plus médiane sont les plus grands); six à sept denticles intermédiaires, un latéral. Les extrémités des dents et denticles sont fortement recourbées vers le haut. La surface ventrale du telson est entièrement lisse sans crête postanale visible.

Uropode.—Le segment basal de l'uropode est pourvu sur le bord interne distal d'une épine dorsale proche de l'articulation avec l'exopodite. L'épine interne du prolongement ventral bifurqué de l'uropode a environ trois fois la longueur de l'externe et porte sur sa face externe un lobe bien développé. Le bord interne de la plus grande épine (interne) est armé de cinq à huit épines aigues. Le bord externe de la plus petite épine (externe) est marqué de faibles denticulations arrondies. Le bord externe du segment basal de l'exopodite porte 5 ou 6 épines mobiles courbes, la dernière étant deux fois aussi longue que la précédente. L'endopodite est nettement plus court que la plus grande épine (interne) du prolongement bifurqué de l'article basal et son extrémité n'atteint pas le niveau de celle de la dent intermédiaire du bord du telson.

Coloration.—Les specimens conservés dans l'alcool ne gardent guère de trace de leur coloration; un specimen (P. 5.614) grand mâle de 86 mm. est cependant d'une tonalité générale gris verdâtre. Sur le petit specimen (P. 6.785 ♀ de 49 mm., 5) les segments



Figures 1–13.

Dimorphisme Sexuel—

Fig. 1. Telson de *Squilla latreillii* ♀ de 72 mm. (E. 3963) x 2·7.
Fig. 2. Telson de *Squilla latreillii* ♂ de 63 mm. (E. 9559) x 2·7.
Fig. 3. Telson *Squilla depressa* ♀ de 77 mm. (E. P.10934) x 2·7.
Fig. 4. Telson de *Squilla depressa* ♂ de 86 mm. (E. P.5614) x 2·1.

Yeux, Rostres et Carapaces de *S. latreillii*, *S. microphthalma*, *S. chlorida*, *S. decorata* et *S. depressa* d'après les auteurs—
Fig. 5. Yeux de *Squilla latreillii*, d'après Eydoux et Souleyet (1841),pl. v, fig. 3.
Fig. 6. Oeil de *Squilla latreillii* d'après Kemp (1913), pl. I, fig. 3.
Fig. 7. Carapace de *Squilla latreillii* d'après Eydoux et Souleyet (1841), pl. v, fig. 4.
Fig. 8. Carapace de *Squilla latreillii* d'après Gravier (1938), fig. 4, p. 164.
Fig. 9. Partie antérieure de *Squilla depressa* d'après Miers (1880), pl. 2, fig. 2.
Fig. 10. Oiel de *Squilla microphthalma* d'après Kemp (1913), pl. I, fig. 17.
Fig. 11. Partie antérieure de *Squilla microphthalma* d'après De Man (1898), pl. 38, fig. 76.
Fig. 12. Partie antérieure de *Squilla chlorida* d'après Brooks (1886), pl. 2, fig. 3.
Fig. 13. Oeil de *Squilla decorata* d'après Kemp (1913), pl. I, fig. 13.

thoraciques et abdominaux sont bordés en arrière par une légère bande de pigment noir, analogue à ce qu'on trouve sur *S. latreillii* et *S. microphthalma*. L'extrémité distale du premier article de l'exopodite de l'uropode porte une tâche de pigments noir de fumée.

Discussion.—Miers (1880) décrit sous le nom de S. *microphthalma* un mâle de 37 mm. 5, de Port Essington (Australie) conservé au British Museum. Ce specimen différant, en particulier pour le rostre, de la description donnée pour *S. microphthalma* par Milne Edwards, Miers propose le nom de *S. depressa* pour le cas où il serait montré par la suite qu'il appartient à une espèce distincte. Miers (1880) étudie en même temps des specimens de *S. latreillii* des collections du British Museum et il ne peut guère douter que le specimen qu'il rapporte avec hésitation à *S. microphthalma* ne peut être rapporté à *S. latreillii ;* s'il le rapproche de *S. microphthalma*, il n'examine aucun specimen de cette forme; il aurait sans doute remarquer en le faisant que *S. depressa* est aussi proche de *S. latreillii* que de *S. microphthalma*, comme la situation de l'espèce le précisera plus loin. Je traduis entièrement la description de Miers : " la carapace est lisse, élargie postérieurement avec une petite épine à l'angle antéro latéral et l'angle postéro latéral très arrondi. Le rostre est petit, semiovale et régulièrement arrondi. Le quatrième segment thoracique, de tous le moins prolongé latéralement, est armé de chaque côté d'une petite spinule; le cinquième, sixième et septième sont plus larges, légèrement prolongés et arrondis sur les côtés[1]. Les premier au cinquième segments abdominaux sont lisses au milieu de la face dorsale, mais faiblement marqués par deux carènes latérales; les angles postéro latéraux de chaque segments sont aigus; sur le sixième segment les carènes submédianes et latérales sont présentes et toutes terminées en épines. Le telson est plus large que long avec une carène médiane obtuse, et de chaque côté de nombreux tubercules irréguliers, avec six dents marginales aigues, entre lesquelles il y a de nombreux denticles plus petits. L'écaille (la pale) antennaire est très petite; le dactyle de la patte ravisseuse est à quatre dents, la terminale étant très longue. Les uropodes sont petits; le prolongement basal de l'uropode est armé sur son bord interne par une série de spinules (comme dans *S. decorata*); l'interne des deux épines est la plus longue et présente une dent épaissie sur son bord externe." Haswell (1882) d'après Miers cite l'espèce parmi les Stomatopodes d'Australie.

De Man (1898) note[2] que sur *S. depressa* " le rostre avec une autre forme que dans *S. microphthalma* est immédiatement contigu aux pédoncules oculaires, tandis que chez *S. microphthalma*, il est séparé de ceux-ci par le segment oculaire (fig. 76 De Man, 1898)." Il signale un autre caractère distinctif : " Sur le prolongement de l'article basal des uropodes la pointe de l'épine interne) (la plus longue, et qui porte à la base une dent émoussée) est courbée vers l'extérieur, et donc vers l'épine externe tandis que dans *S. microphthalma* elle est tournée vers l'intérieur." Miers ne signale pas ce caractère et De Man se réfère sans doute seulement à la figure de Miers, figure bien insuffisante pour qu'on puisse l'utiliser avec cette rigueur.

Jurich (1904) à propos du specimen de *S. depressa* de Miers note[3] " le rostre dessiné par Miers (1880, table II, fig. 2) est exactement hémi-circulaire et s'étend immédiatement jusqu'à la base des pédoncules oculaires, tandis que le rostre chez *S. microphthalma* est hémiovoide et laisse découvert tout le segment oculaire." Il déduit de la remarque de Miers " les angles postéro latéraux de chaque segment abdominal sont aigus" (Miers, 1880, p. 14) que les angles postérieurs du 5è et du 6è segment abdominal ne présentent pas d'épines comme c'est le cas dans *S. microphthalma ;* point important sur lequel, je reviens plus loin. Enfin d'après le dessin lui aussi, et donc sans référence suffisante, il signale que la forme du telson et du prolongement ventral de l'uropode (Miers, 1880, table II, fig. 4) est tout à fait différente de la forme typique de *S. microphthalma.*

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[1] Pour ces segments il faut lire le 5° au lieu du 4°, le 6, 7 et 8° au lieu des 5°, 6° et 7°, car Miers compte le 1° segment thoracique à partir de la patte ravisseuse, qui en réalité correspond au segment 2.

[2] De Man (1898) in *Squilla microphthalma*, p. 691

[3] Jurich (1904) in *Squilla microphthalma*, p. 368.

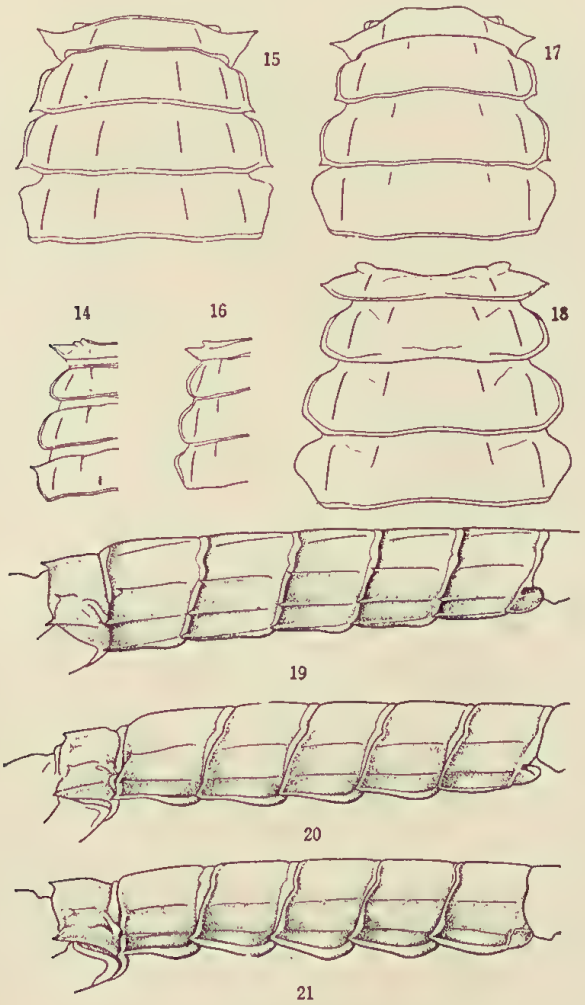
Kemp (1913) n'examine non plus aucun specimen mais insiste[4] d'après Miers (1880) sur le fait que les bords internes des prolongements ventraux de l'uropode sont armés seulement de petits spinules comme dans *S. decorata* et pense qu'il s'agit sans doute d'une variété nouvelle que la découverte de nouveaux specimens australiens permettra de confirmer.

Mr. Tweedie, Directeur du Raffles Museum ayant examiné avant moi les specimens de l'Australian Museum étudiés ici a redigé en anglais une note qui m'a été remise par Mr. McNeill de l'Australian Museum et dont voici la traduction: (P. 5.614) 1°—le rostre est beaucoup plus large que long, 2°—toutes les carènes marginales abdominales se terminent en épines. Dans "*S. microphthalma*, (nouveau nom proposé: *depressa*, Miers, 1880, p. 14–15), ces deux caractères sont décrits; et c'est probablement l'espèce ici obtenue qui est mentionnée par Kemp (p. 32). Kemp exagère la différence entre épines et spinules sur le prolongement ventral de l'uropode. Le specimen de Miers était petit ($1\frac{1}{2}$ pouce = 37 mm., 5) et les épines étaient très petites. Les figures de Miers sont complètement inutilisables; l'espèce doit être rédécrite, le nom *depressa* pouvant être employé puisque Miers a donné des figures de texte. Le specimen P. 5.614 est un beau mâle adulte." Suivant la suggestion de Mr. Tweedie j'ai redigé une diagnose nouvelle d'après l'échantillon P. 5.614, qui est un mâle de 86 mm. Un nouvel examen du type de Miers au British Museum est toutefois souhaitable.

Dimorphisme sexuel.—Si on connait le dimorphisme sexuel de *S. latreillii* et de certaines espèces voisines on ne possède que très peu d'observations à son sujet. Kemp (1913) signale rapidement les déformations qui marquent la patte ravisseuse et le telson des mâles de *S. gibba* et à propos de *S. latreillii* écrit seulement " dans les mâles adultes, la carène médiane est plus forte que dans les femelles, il y a un énorme triangle renflé à la base de chaque dent marginale et tous les tubercules sont généralement plus arrondis, et moins nets que dans l'autre sexe." Kemp donne cependant deux bonnes figures du telson d'un mâle et d'une femelle (Kemp, 1913, pl. I, fig. 164). L'étude que j'ai faite récemment du dimorphisme sexuel de *S. latreillii* éclaire le dimorphisme sexuel analogue de la patte ravisseuse, du telson et du sixième segment abdominal que l'on retrouve sur *S. depressa*. L'examen des pattes ravisseuses des deux specimens adultes, mâle et femelle, de la présente collection n'aurait rien révélé en particulier sur le dactyle, si je n'avais été guidé par ma récente étude de *S. latreillii*. Le dactyle du mâle présente dans la moitié proximale de son bord externe un léger renflement qui donne à l'ensemble de ce bord un aspect de courbe convexe regulière de son angle proximal à son extrémité distale; sur la femelle ce bord est légèrement sinueux avec une partie proximale droite courte suivie d'une légère concavité, puis de la convexité du bord externe de la dent terminale. Les dents sont légèrement plus fortes sur le mâle et le propodus y est élargi dans l'angle distal externe. Le merus est beaucoup plus robuste. En définitive, si le dimorphisme marque la patte ravisseuse comme dans *S. latreillii*, il est peu marqué et la collection est bien insuffisante en nombre pour donner plus qu'une simple indication.

L'examen du dimorphisme sexuel du sixième segment abdominal et surtout du telson de *S. depressa* présente au contraire un grand intérêt. La comparaison du telson du mâle avec celui de la grande femelle de *S. depressa* rapprochée de celle d'un mâle et d'une femelle de *S. latreillii* et de celle d'un mâle et d'une femelle de *S. microphthalma* montrent en effet que les caractères distinctifs des telsons de ces espèces ne peuvent être établis qu'en tenant compte des effets du dimorphisme sexuel. Chez *S depressa*, la face dorsale du telson porte une carène médiane avec de part et d'autre une rangée longitudinale de deux ou trois tubercules irréguliers disposés d'arrière en avant comme sur une paire de carènes médiane secondaire et une autre rangée transverse oblique de trois à quatre tubercules irréguliers entre l'extrémité terminale de la carène

[4] Kemp (1913) in *Squilla microphthalma*, p. 31.



Figures 14–21.

Segments Thoraciques—

Fig. 14. *Squilla latreillii*, d'après Kemp (1913), pl. I, fig. 4.
Fig. 15. *Squilla latreillii* (original) (E. 4003 ♂ de 85 mm.).
Fig. 16. *Squilla microphthalma*, d'après Kemp (1913), pl. I, fig. 18.
Fig. 17. *Squilla microphthalma* (original) (E. 9163 ♂ de 85 mm.).
Fig. 18. *Squilla depressa* (original) (P. 5.614 ♂ de 86 mm.).

Segments Abdominaux—

Fig. 19. *Squilla latreillii* ♀ de 84 mm. (E. 4196).
Fig. 20. *Squilla microphthalma* ♂ de 85 mm. (E. 9163).
Fig. 21. *Squilla depressa* ♂ de 86 mm. (E. P.5614).

médiane et la dent latérale. La comparaison avec les telsons de *S. latreillii* ou de *S. microphthalma* éclaire cette disposition : dans ces dernières espèces, la première rangée est formée de 6 à 7 tubercules réguliers en ligne courbe et la deuxième est remplacée par une série de 5 à 6 rangées longitudinales courbes de petits tubercules réguliers allant du bord du telson aux tubercules de la première rangée. Les dessins établis d'après mes specimens montrent que le telson de la femelle de *S. depressa*, porte un reste très effacé de la disposition de *S. latreillii*; sur celui du mâle la déformation due au dimorphisme rend plus difficile la reconnaissance des grandes lignes de la disposition; chez *S. latreillii* elle est encore très nette (voir aussi Dollfus, 1938, fig. 4). Chez *S. microphthalma* les auteurs (Jurich, 1904, pl. xxvi, fig. 1 et Kemp, 1913, pl. I, fig. 17–20) ne figurent à ce jour que des femelles et je donne la photographie du telson d'un mâle de mes collections. Aussi bien chez la femelle que le mâle la disposition est intermédiaire entre celle de *S. latreillii* et celle de *S. depressa*. Sur *S. rotundicauda*, on trouve aussi une disposition analogue (Miers, 1880, pl. 2, fig. 6 et Schmitt, 1929, pl. 16, fig. 3 et 4). On ne connait qu'une femelle de *S. decorata* dont le telson est tout à fait comparable à celui de *S. latreillii*. Pour en rester à *S. depressa*; le dimorphisme sexuel épaissit considérablement sur le mâle la carène médiane et les tubercules en particulier ceux de la base des dents submédianes, intermédiaires et latérales; ces tubercules et les autres sont beaucoup plus arrondis que dans les espèces voisines. La déformation par épaississement des carènes du sixième segment abdominal est aussi plus accentuée que sur *S. latreillii* et *S. microphthalma*.

Situation de l'espèce.—L'espèce est très proche de *S. latreillii* et de *S. microphthalma*, présentant certains caractères de l'une de ces espèces et certains caractères de l'autre. Mais on n'a guère signalé à ce jour qu'une dizaine de specimens de chacune de ces deux espèces, qui sont cependant les mieux connues de toutes celles du groupe *latreillii*, et leur diagnose laisse des points douteux. En étudiant une collection (de l'Institut Océanographique de l'Indochine) contenant 13 specimens de *S. latreillii* et 2 de *S. microphthalma* j'ai fait récemment une revision générale de ces deux espèces. Dans le tableau de comparaison des caractères de *S. depressa* avec ceux de *S. latreillii* et *S. microphthalma* je me refère aux specimens examinés dans cette étude[5]. Le tableau est accompagné d'une importante figuration; j'y ajoute pour certains de ses caractères quelques commentaires qui intéressent en particulier : 1°—les yeux et le segment ophthalmique, 2°—les antennes, les antennules, le rostre (forme et dimension), la carapace et la patte ravisseuse, 3°—les segments thoraciques, 4°—la formule spinale, 5°—l'uropode.

Dans *S. microphthalma* et *S. rotundicauda*, les yeux sont nettement plus longs que dans toutes les autres espèces du groupe *S. latreillii*; de même sauf dans *S. chlorida*, la cornée dans ces deux espèces est plus large que dans les autres. Dans toutes ces espèces c'est-à-dire : *S. latreillii*, *S. decorata*, *S. gibba*, *S. choprai*, la cornée est beaucoup plus petite, le pédoncule oculaire plus large et plus court : différences de dimensions qui s'accompagnent de modifications de forme. Les yeux de *S. depressa* par leur dimension se rapprochent de ceux de *S. latreillii* et par leur forme de ceux de *S. microphthalma* et *S. rotundicauda*. L'indice de cornée pour des spécimens de même taille (85 mm.) est de 16 ou 15 dans *S. latreillii*, et 11 dans *S. microphthalma*, de 16 dans *S. depressa*. Avec des yeux plus longs et à cornée plus large, *S. microphthalma* possède carapace et rostre plus longs, prolongements dorsaux du segment ophthalmique plus développés que dans *S. latreillii*; au contraire les antennes, les antennules et les pattes ravisseuses sont comparativement plus courtes sur *S. microphthalma* que sur *S. latreillii*. Pour tous ces points *S. depressa* est beaucoup plus proche de *S. latreillii* que de *S. microphthalma*. Par contre le relief de la carapace en particulier l'absence de toute carène latérale la rapproche de *S. microphthalma*. Gravier (1937) donne une bonne figure de la carapace de *S. latreillii*, précisant des zônes en relief dans la partie antérieure de l'aire gastrique. On retrouve quelque chose d'analogue dans *S. microphthalma*, mais aucunement sur

[5] Non encore publiée.

*8718—2

	Squilla latreillii.	*Squilla microphthalma.*	*Squilla depressa.*
L'extrémité antérieure des Pédoncules oculaires.	—n'atteint pas la 1/2 de la longueur de l'article basal du pédoncule antennulaire. —n'atteint pas de beaucoup le second article de l'endopodite antennaire.	—Atteint aux 2/3 de la longueur de l'article basal du pédoncule antennulaire. —atteint le second article de l'endopodite antennaire.	—comme *S. latreillii.* —comme *S. latreillii.*
La plus grande largeur du pédoncule oculaire.	—a environ les 3/4 de sa longueur (rapport 22/35).	—a 1/2 de sa longueur (rapport 21/43) ...	—comme *S. latreillii* (rapport 19/34).
Largeur de la cornée	—légèrement moins de la moitié de la plus grande largeur du pédoncule oculaire (rapport 10/22). —presque 1/4 de la longueur de tout l'organe (rapport 10/35).	—3/4 de la plus grande largeur du pédoncule oculaire (rapport 15/21). —1/3 de la longueur de tout l'organe (rapport 15/43).	—légèrement plus de la moitié de la plus grande largeur du pédoncule oculaire (rapport 10/19). —comme *S. latreillii* (rapport 10/34).
Prolongements dorsaux du segment ophthalmique.	—peu développés avec leur bord antérieur presque droit avec une légère inflexion médiane en creux.	—bien développés en deux lobes arrondis avec leur bord antérieur bilobé.	—comme *S. latreillii.*
Pédoncule antennulaire	—plus long que la carapace avec rostre ...	—plus court que la carapace sans rostre ...	—plus long que la carapace sans rostre et plus court que la carapace avec rostre.
Longueur totale de l'antennule	—environ 1/3 de la longueur totale du corps, mesurée entre l'extrémité antérieure du rostre et l'extrémité postérieure du telson.	—environ 1/4 de la longueur totale du corps.	—comme *S. latreillii.*
Carapace	—la plus grande largeur (postérieure) est égale au double (52/26) de la plus petite antérieure et à peu près égale à la longueur médiane rostre exclus. —partie antérieure de l'aire gastrique compartimentée avec zône saillan: e. —carène latérale nette	—la plus grande largeur (postérieure) est égale à presque trois fois (50/21) la plus petite (antérieure) et à peu près égale à la longueur médiane rostre exclus. —partie antérieure de l'aire gastrique moins marquée. —pas de carène latérale	—la plus grande largeur (postérieure) est égale au double (50/25) de la plus petite (antérieure) et à peu près égale à la longueur médiane rostre exclus. —encore moins marquée et lisse. —comme *S. microphthalma.*
Patte ravisseuse	—(longue) l'extrémité antérieure du merus dépasse de beaucoup le bord antérieure des yeux et atteint l'extrémité antérieure de l'article basal de l'endopodite antennaire.	—(courte) l'extrémité antérieure du merus n'atteint pas l'extrémité antérieure des yeux et n'atteint guère que la base de l'article basal de l'endopodite antennaire.	—(longue) comme *S. latreillii.*
Sur les segments thoraciques, les prolongements latéraux.	—du cinquième sont en grande épine tournée vers l'avant. —du sixième et du septième sont en angles droits arrondis en avant avec une petite spinule en arrière. —du huitième sont en avant en angle droit aigu.	—du cinquième sont en petite épine droite vers l'extérieur. —du sixième et septième sont arrondis tronqués en avant avec une très petite spinule en arrière. —du huitième sont en avant arrondi ...	—comme *S. microphthalma* —du sixième et septième sont arrondis tronqués en avant et en arrière. —comme *S. microphthalma.*
Sur les cinq premiers segments abdominaux.	—traces de carènes submédianes	—pas de traces de carènes submédianes ...	—comme *S. microphthalma.*
Carènes marginales des segments abdominaux terminées en épines.	—(2) (3), 4, 5	—(3), 4, 5	—(1), 2, 3, 4, 5.
L'endopodite de l'uropode	—est plus long que l'épine interne du prolongement bifurqué de l'article basal de l'uropode. —son extrémité distale atteint le niveau du bord postérieur (dent submédiane) du telson.	—est de même longueur que l'épine interne du prolongement bifurqué de l'article basal de l'uropode. —son extrémité distale atteint à peine le niveau de l'extrémité de la dent intermédiaire du telson.	—est plus court que l'épine interne du prolongement bifurqué de l'article basal de l'uropode. —n'atteint pas le niveau de l'extrémité de la dent intermédiaire du telson.

S. depressa qui n'a qu'un relief très effacé. Les dimensions de la carapace sur des specimens de même taille des trois espèces montrent qu'elle est plus large sur *S. depressa* que sur les autres espèces; ses bords latéraux sont beaucoup plus droits, moins concaves dans la partie antérieure.

	No. Echantillons.	Longueur totale.	Largeur entre les épines antéro-latérales.	Longueur rostre compris.	Plus grande largeur.
S. latreillii	E. 4003	85 mm.	8 mm.	17 mm.	16 mm.
S. microphthalma	E. 9163	85 mm.	7 mm.	20 mm.	16 mm.
S. depressa	P. 5614	86 mm.	9 mm.	18 mm.	17 mm.

Les prolongements latéraux des quatre derniers segments thoraciques, en particulier celui en épine du cinquième segment, donnent aussi un bon caractère distinctif de ces espèces. Les dessins établis d'après mes specimens montrent qu'ils diffèrent légèrement pour *S. latreillii* et *S. microphthalma* de ceux de Kemp (1913) que je rapproche.

Mr. Tweedie dans sa note attire l'attention sur la spinulation de toutes les carènes marginales comme sur un des principaux caractères propres à l'espèce; je rapproche ici les formules spinales des trois espèces :

Carènes.	Segments.		
	S. latreillii	*S. microphthalma*	*S. depressa*
Submédianes	6	6	6
Intermédiaires	5, 6	5, 6	5, 6
Latérales	5, 6	5, 6	5, 6
Marginales	(2) (3), 4, 5.	3, 4, 5.	(1), 2, 3, 4, 5.

L'étude de douze specimens de *S. latreillii* m'a montré que la formule spinale de cette espèce est assez variable, comme Kemp (1913) déjà le signale; ainsi un specimen de ma collection (E. 4.196, femelle de 84 mm.) a ses carènes marginales des segments 2, 3, 4, 5 terminées en épines; ce qui est très voisin de ce que présente *S. depressa*; toutefois cette dernière espèce seule porte d'ordinaire sur le premier segment un angle postéro latéral en épine, et surtout les épines y sont toujours beaucoup plus fortes et plus différenciées sur tous les segments. Les bords latéraux des segments abdominaux dans les trois espèces montrent également que la carène marginale est beaucoup plus forte, plus épaissie dans *S. depressa*. Miers (1880) écrivant seulement que " les angles postéro latéraux de chaque segment (abdominal) sont aigus " et ne parlant pas d'épines proprement dites, c'est un point où l'examen du specimen type parait essentiel.

Mr. Tweedie remarque à juste titre que Kemp (1913) exagère la différence entre épines et spinules sur l'épine interne du prolongement bifurqué de l'uropode. Sur les trois specimens de *S. depressa* ici étudiés, les épines sont aigues et tout à fait comparables à celles de *S. latreillii* et *S. microphthalma*. Leur nombre varie entre 6 et 8 comme dans ces espèces; de même pour le nombre des épines mobiles de l'exopodite. Enfin, l'endopodite des trois dernières pattes thoraciques est dans *S. depressa*, légèrement plus élargi à son extrémité distale que dans les deux espèces voisines.

Plusieurs des caractères de la diagnose et du tableau de comparaison sont propres à *S. depressa* et ne se retrouvent ni dans *S. latreillii*, ni dans *S. microphthalma*. La forme des yeux et du rostre (intermédiaire entre celles de ces deux espèces), la forme, le relief et les dimensions de la carapace, les bords des segments thoraciques, la longueur de l'endopodite de l'uropode sont assez caractéristiques dans *S. depressa* pour qu'on la considère sans hésitation comme une espèce vraie.

La collection contient trois specimens : 1 mâle de 86 mm. (P. 5614) et deux femelles une de 77 mm. (P. 10934) et une de 49 mm. 5 (P. 6.785). Le premier a été recueilli à Port Denison (Queensland), le second à Mackay (North Queensland) le troisième au récif de la Grande Barrière (Queensland). Tous trois sont à l'Australian Museum de Sydney.

Historique.—L'espèce n'est connue que d'Australie et par le seul specimen de Miers (1880). Haswell (1882) cite l'espèce dans ses Stomatopodes d'Australie en se référant seulement à la publication de Miers.

Squilla depressa Miers.

		Corps.	Carapace.				Oeil.				Segments.		Telson.	
Nos. d'Echantillons.	Sexe.	Longueur totale yeux compris.	Largeur antérieure.	Largeur postérieure.	Longueur rostre compris.	Longueur rostre exclus.	Longueur pédoncule antennulaire.	Longueur de l'oeil.	Largeur de la cornée.	Indice de cornée.	Largeur 5è segment thoracique.	Largeur 5è segment abdominal.	Plus grande largeur.	Plus grande longueur.
P. 5614	♂	86	9	17	18	16	17·5	3	1	16·00	13	20	18	15
P. 10934	♀	77	7	13·5	15	13·5	13	3	1	13·50	11	16·5	14·5	11
P. 6785	♀	49·5	5	9·5	10	9	10	2·5	1	9·00	7·5	11	10	7

Lysiosquilla multifasciata Wood-Mason.

1876—*Squilla*, Heckel, p. 46, pl. III, fig. IV.
1895—*Lysiosquilla multifasciata*, Wood-Mason, p. 1, pl. I, fig. 4–7.
1903—*Lysiosquilla multifasciata*, Nobili, p. 30.
1904—*Lysiosquilla valdiviensis*, Jurich, p. 372, pl. XXVI, fig. 2–2g.
1906—*Lysiosquilla multifasciata*, Nobili, p. 337.
1910—*Lysiosquilla multifasciata*, Balss, p. 6.
1913—*Lysiosquilla multifasciata*, Kemp, p. 122.
1915—*Lysiosquilla multifasciata*, Kemp, p. 175, pl. I, fig. 2, 3.
1921—*Lysiosquilla multifasciata*, Tattersall, p. 359, pl. 28, fig. 6.
1927—*Lysiosquilla multifasciata*, Komai, p. 332.
1929—*Lysiosquilla multifasciata*, Schmitt, p. 144, pl. 19, fig. 15–18.
1930—*Lysiosquilla multifasciata*, Roxas and Estampador, p. 113.
1937—*Lysiosquilla*, Gravier, p. 199, fig. 15–16.
1938—*Lysiosquilla multifasciata*, Dollfus, p. 203, fig. 11.
1938—*Lysiosquilla multifasciata*, Komai, p. 271.
1938—*Lysiosquilla acanthocarpus*, Serène, pp. 345–346, fig. 1, 2, 3, 4.
1939—*Lysiosquilla multifasciata*, Chopra, pp. 162–165, fig. 8, 9.
1941—*Lysiosquilla multifasciata*; Holthuis, p. 274.
1949—*Lysiosquilla multifasciata*, Tweedie, p. 39, fig. 1a et b.

Je rapporte à cette espèce une femelle de 64 mm. (P. 4.843). Mr. Tweedie a noté au sujet de cet échantillon : " Etiqueté " *Lysiosquilla acanthocarpus* ? " Elle est en réalité tout à fait *L. multifasciata* (Kemp 1913, p. 122) Base du dactyle : (*a*) un petit lobe proximal, (*b*) un grand lobe distal."

L'examen du specimen confirme la détermination de Mr. Tweedie. La photographie du dactyle du specimen rapprochée des dessins de cet appendice donnés par Tattersall (1921) et Tweedie (1949) montre bien le développement du second renflement distal du bord externe, caractère essentiel qui distinque l'espèce de *L. acanthocarpus*. La liste des specimens récoltés à ce jour précise la répartition géographique de l'espèce et la taille des specimens; le plus grand specimen connu est une femelle de 75 mm. signalée par Tweedie (1949).

1895—Wood-Mason	1 ♀ 44 mm.	Bombay (Inde).
1903—Nobili	1 ♀	Samarinda (Bornéo).
1904—Jurich	14,6 mm.	localité inconnue.
1906—Nobili	3 dont 1 ♂ de 31 mm.	Obock (Mer Rouge).
1910—Balss		Formose.
1915—Kemp	7, 2, ♂, ♀ 28–56 mm.	Port Galera, Mindoro (Philippines).
1921—Tattersall	1 ♂	Mer Rouge.
1927—Komai	3 ♂ 27–40 mm.	Tateyama (Japon).
	1 ♀ 39 mm.	Seto (Japon).
	1 ♀ 45 mm.	Nagasaki (Japon).
1929—Schmitt	1 ♀ 49 mm.	Amoy (Chine).
1938—Dollfus	1 ♂	Golfe de Tadjourah (Mer Rouge).
	1 ♀	,, ,, ,, ,,
1938—Komai	1 ♀ 39 mm.	Seto (Japon).
1939—Chopra	5 ♂ 64, 59, 53, 53, 45 mm.	Golfe d'Oman (Océan Indien).
	4 ♀ 58, 56, 45, 41 mm.	,, ,, ,,
1941—Holthuis	1 ♂ 24 mm.	Kamaran (Mer Rouge).
1949—Tweedie	1 ♀ 75 mm.	Sandakan (Nord Bornéo Britannique).

L'espèce n'avait jamais été signalée en Australie.

Le specimen de la collection (P. 4.843) a été récolté à l'île Dunk du " Family Group " (Queensland).

Lysiosquilla acanthocarpus Miers.

1847—*Coronis acanthocarpus*, White (Gray Ms.), p. 85 (since desc.).
1880—*Lysiosquilla acanthocarpus*, Miers, p. 11 et p. 125, pl. I, figs. 7–9.
1882—*Lysiosquilla acanthocarpus*, Haswell, p. 206.
1886—*Lysiosquilla sarasinorum*, Muller, p. 478, pl. iv, fig. 3.
1894—*Lysiosquilla acanthocarpus*, Bigelow, p. 503.
1894—*Lysiosquilla sarasinorum*, Bigelow, p. 503.
1904—*Lysiosquilla acanthocarpus*, Jurich, p. 374, pl. 26, fig. 3.
1910—*Lysiosquilla acanthocarpus*, Balss, p. 6.
1910—*Lysiosquilla acanthocarpus*, Fukuda, p. 146.
1913—*Lysiosquilla acanthocarpus*, Kemp, pp. 120–122.
1915—*Lysiosquilla acanthocarpus*, Kemp, p. 174.
1924—*Lysiosquilla acanthocarpus*, Hale, p. 497.
1927—*Lysiosquilla acanthocarpus*, Komai, p. 332.
1930—*Lysiosquilla acanthocarpus*, Komai et Tung, pp. 13–19.
1934—*Lysiosquilla acanthocarpus*, Chopra, p. 30.
1949—*Lysiosquilla acanthocarpus*, Tweedie, p. 40.

Je rapporte à cette espèce une femelle de 85 mm. (P. 6.788) de la collection. Mr. Tweedie a noté à propos de cet échantillon : " Etiquetée '*Squillidae*' = *Lysiosquilla acanthocarpus* Miers. Elle est très typique dans chaque détail, excepté qu'il y a une

petite épine supplémentaire à la base du dactyle de la patte ravisseuse portant le nombre total à 7. Elle n'a pas toutefois, les caractères de la *var. septemspinosa* Miers (voir Kemp 1913, p. 122). A mon avis, elle peut être considérée comme *acanthocarpus* typique."

Figures 22–27.

Patte Ravisseuse—

Fig. 22. *Lysiosquilla multifasciata* d'après Tattersall (1921), Pl. 28, fig. 6.
Fig. 23. *Lysiosquilla multifasciata* d'après Tweedie (1940), Fig. 1a, Page 39.
Fig. 24. *Lysiosquilla multifasciata* (face interne) ♀ de 64 mm. (P. 4.843) x 4·4.
Fig. 25. *Lysiosquilla acanthocarpus* d'après Komai (1927), Pl. 14, Fig. 4b (specimen de Sima).
Fig. 26. *Lysiosquilla acanthocarpus* d'après Komai (1927), Pl. 14, Fig. 4 (specimen de Formosa).
Fig. 27. *Lysiosquilla acanthocarpus* (face interne) ♀ de 85 mm. (P. 6.788) x 3·2.

L'examen confirme la détermination de Mr. Tweedie. La variété *septemspinosa* Miers décrite d'après un specimen de Gorée (Sénégambie) est de l'Atlantique. Kemp (1913) pense qu'il s'agit peut être d'une espèce distincte. Le présent specimen, s'il a une ébauche de septième dent au dactyle, ne possède en tout cas ni le rostre transverse, ni les yeux plus petits caractéristiques de la variété de Miers. La variation du nombre des dents du dactyle parait un fait assez normal dans l'espèce. Komai (1927) signale un specimen de Sima (Japon) avec neuf dents sur le dactyle et un de Giran (Formose) avec sept dents; Kemp (1913) en trouve généralement six.

La liste des specimens signalés à ce jour avec leur taille précise aussi la répartition géographique de l'espèce.

1880a—Miers	1 ♀ 2 1/2 pouce	Port Essington (Australie).
1880b—Miers	1	Penang (Malaisie).
1886—Muller	sans indication de taille	Trincomali (Ceylan).
1904—Jurich	1 ♂ 76 mm.	(Musée de Vienne).
	1 ♀ 67 mm.	Nouvelle Guinée (Musée de Dresden).
1910—Balss		Takao, Formosa.
1910—Fukuda	1 ♂	Tateyama, Province Awa (Japon).
1913—Kemp	1 ♀ 41 mm.	Port Blair, Andamans (Inde).
	1, 5 ♂♀ 48–74 mm.	Coconada, Madras (Inde).
	1 ♀ 86 mm.	„ „ (Inde).
	2 ♀ 65, 85 mm.	Bombay (Inde).
1915—Kemp	1 ♀ 66 mm.	Bantayan, Province de Cebu (Philippines).
1927—Komai	1 ♀ 61.5 mm.	Province Sima (Japon).
	1 ♀ 53 mm.	Giran (Formose).
1930—Komai and Tung	1 ♂ 52 mm.	Senoumi, Surriga Bay (Japon).
	1 ♀ 57.5 mm.	„ „ „
1934—Chopra	1 ♀ 81 mm.	Sandheads (Indes).
1949—Tweedie	1	Morib, Détroit de Malacca.
	1	Bachock, Kelantan (Côte Est de la Péninsule, Malaise).

On ne connait donc que 23 specimens : le plus grand est une femelle de 85 mm. signalée par Kemp 1913 ; celui de la présente collection a la même taille.

L'espèce a été découverte en Australie, le specimen type conservé au British Museum et décrit par Miers (1880) a été récolté à Port Essington par Sir J. Richardson ; elle n'avait jamais été retrouvée en Australie ; Haswell (1882) et Alexander (1916) la citent dans les espèces d'Australie en se référant au specimen de Miers (1880). Hale (1927) ne la cite pas parmi les espèces de l'Australie Sud, où il trouve cependant trois espèces de *Lysiosquilla* : *L. perpasta* Hale, *L. vercoi* Hale, *L. oscularis* Hale.

Le specimen de la collection (P. 6.788) a été récolté à la Baie du Paradis de l'île Nord du " Edward Pellew Group " dans le Golfe de Carpentaria.

Gonodactylus spinosocarinatus Fukuda.

1910—*Gonodactylus spinosocarinatus*, Fukuda, p. 143, pl. IV, fig. 2, 2a.
1913—*Gonodactylus spinosocarinatus*, Kemp, p. 173.
1926—*Gonodactylus strigatus*, Hansen, p. 31, pl. II, fig. 2a, 2b.
1930—*Gonodactylus demani* var. *pruvotoe*, Gravier, pp. 214, 216, fig. 1.
1949—*Gonodactylus strigatus*, Serène, pp. 225–231 avec 2 fig.

Je rapporte à cette forme deux specimens (P. 10.372) de la collection.

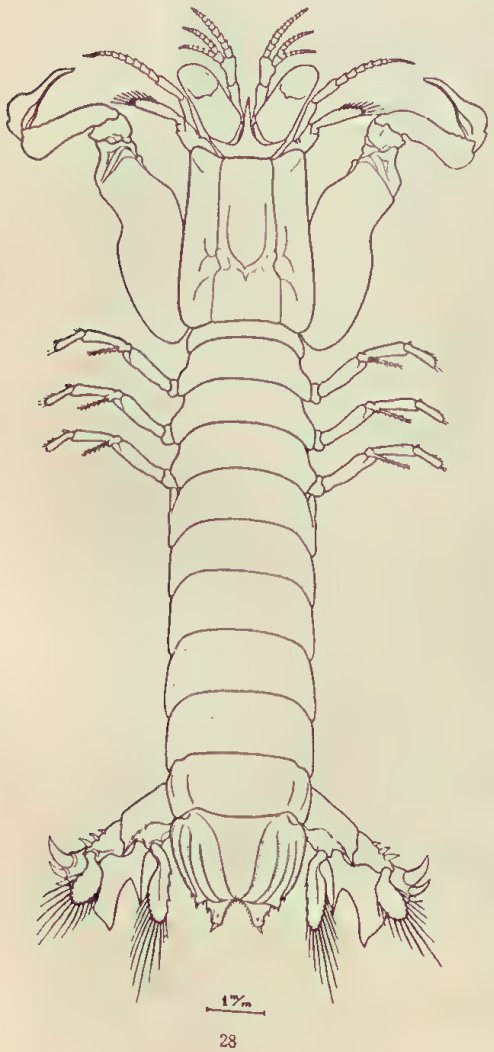
L'espèce appartient au groupe II des *Gonodactylus* de Kemp (1913), dont les espèces sont surtout caractérisées par la disposition particulière des épines mobiles du bord externe du premier article de l'exopodite de l'uropode. Le caractère spécifique le plus net de *G. spinosocarinatus* est la disposition du relief de la face dorsale du telson.

Dans une étude consacrée récemment à *G. spinosocarinatus* j'ai fait entrer en synonymie avec cette espèce, le *G. strigatus* Hansen 1926 et le *G. demani* var. *pruvotoe* Gr v er 1930. Avant de signaler rapidement les caractères qui permettent de rapporter à cette espèce les deux specimens (P. 10.372) de la présente collection, je donne la traduction des notes de Mr. Tweedie à propos de ces specimens : " Un *Gonodactylus* particulier intermédiaire entre les groupes " I " et " II " de Kemp. Le rostre n'est pas

triépineux (" I "), mais les épines distales du bord externe de l'article proximal de l'exopode de l'uropode sont recourbées comme dans les espèces du groupe " II". Peut être (une espèce) très étroite alliée de *spinosocarinatus*. Autre nouvelle espèce."

A mon avis, la disposition du rostre triépineux ou non ne constitue pas un caractère net de séparation entre les espèces du groupe I et celles du groupe II. En effet, d'une part, certaines espèces du groupe I possèdent un rostre avec un léger caractère triépineux : tel le *G. smithi* (= *G. acutirostris*) du groupe I ; d'autre part, les auteurs ne donnent que des indications assez vagues sur le caractère *triépineux* des espèces du groupe II : sur les specimens de *G. spinosocarinatus* d'Australie, comme sur ceux d'Indochine que j'ai examinés, le rostre s'il n'est pas triépineux a ses angles antéro latéraux aigus ; ce qui est en accord avec la diagnose de Fukuda (1910).

La disposition de l'uropode et du telson des specimens d'Australie suffit à les faire rapporter sans grande hésitation à *G. spinosocarinatus* ; tous les autres caractères concordent avec ceux des specimens d'Indochine que j'ai étudiés et à propos desquels j'ai fait un examen des variations et des légères différences avec ceux décrits par Fukuda (1910), Hansen (1926) et Gravier (1930).



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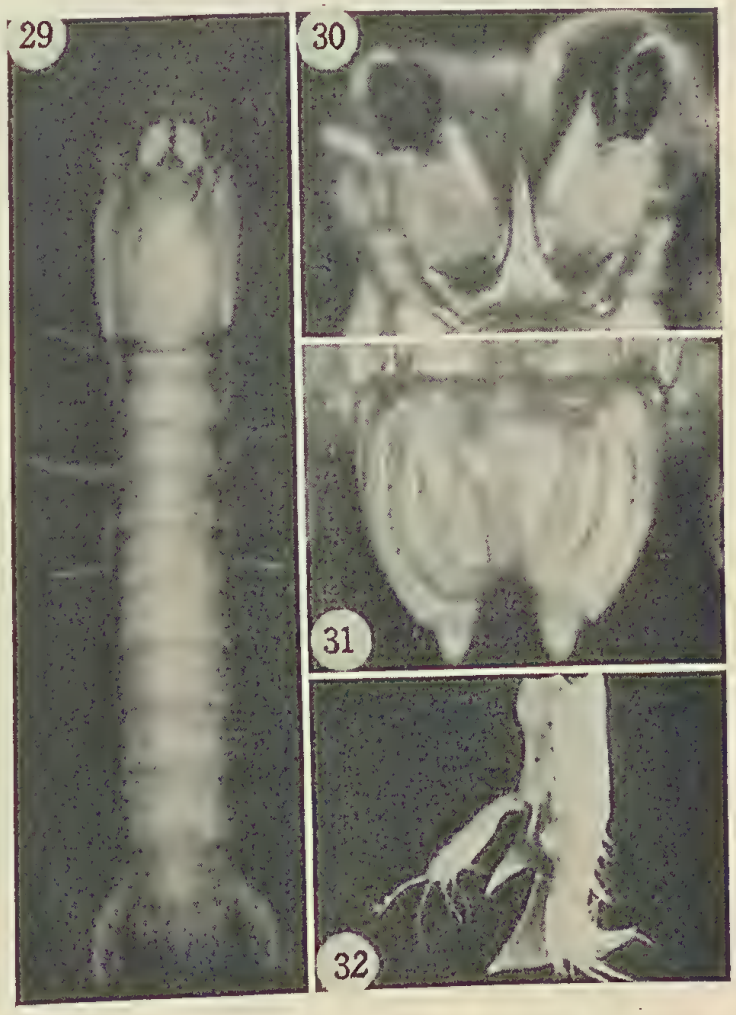


Figures 28–32.

Gonodactylus spinosocarinatus Fukuda (1910)—

Fig. 28. Femelle de 14 mm. de long (E. 14.821) x 6.
Fig. 29. Animal entier ♀ de 16 mm. (E. 14.832) x 6.
Fig. 30. Partie antérieure montrant yeux & rostre ♀ de 16 mm. (E. 14.832) x 13.
Fig. 31. Telson (vue dorsale) ♀ de 14 mm. (E. 14.821) x 17.
Fig. 32. Uropode droit ♂ de 16 mm, 5 (E. 14.820) x 13.

Je signale seulement que : les yeux grands et de forme conique sont plus larges à la base et diminuent graduellement jusqu'à l'extrémité arrondie de la cornée. Les antennules et antennes sont très courtes. Tous les segments du corps sont fortement convexes et étroits. Ce qui donne à l'espèce un aspect allongé très particulier par comparaison avec les autres *Gonodactylus*. Les uropodes sont caractérisés en particulier par le bord externe du premier article de l'exopodite avec trois épines proximales inclinées en arrière comme dans les autres espèces, puis trois épines distales beaucoup plus larges, recourbées en avant et de taille décroissante de la proximale à la terminale. Le telson très haut porte neuf carènes dont les cinq médianes sont plus épaisses. Dans les sillons entre les carènes il y a deux rangées de petites spinules. Sur le bord postérieur du telson l'excavation est large entre les dents submédianes terminées par une épine mobile fortement courbée vers le haut: puis en allant vers l'extérieur on note une dent intermédiaire et une dent latérale à peine marquées avec deux denticles entre la submédiane et l'intermédiaire. A l'extérieur de la dent latérale, le bord du telson forme une ligne convexe sans coupure.

Historique.—Fukuda (1910) crée l'espèce pour deux femelles (la plus grande de 28 mm., 5 de long) récoltées au Japon à Yogashima (Province de Sagami). Dans un travail à paraitre sur les Stomatopodes d'Indochine je signale seize specimens (le plus grand de 17 mm.). Sous le nom de *G. strigatus*, Hansen (1926) signale un specimen de 10 mm. de long de la Station 213 du Siboga, récolté à Saleyer, petite ile au Sud des Célèbes; sous le même nom j'ai signalé (Serène, 1949) une femelle de 18 mm. récoltée en Indochine. Sous le nom de *G. demani* var. *pruvotoe*, Gravier (1930) cite 4 specimens entre 12 et 20 mm. de Nouvelle Calédonie. L'espèce est donc connue du Japon (Fukuda, 1910), des Célèbes (Hansen 1926), de la Nouvelle Calédonie (Gravier 1930) et de l'Indochine (Serène 1949 et manuscrit à paraitre). On en connait 24 specimens, auxquels s'ajoutent les deux de la présente collection, qui ont 20 et 18 mm. de long.

Aucun auteur ne donnant de précisions sur l'habitat de l'espèce, je signale que *G. spinosocarinatus* a été trouvé en Indochine à Nhatrang et à Poulo Condore dans la zone de balancement des marées, en cassant des blocs de coraux morts. Comme tous les *Gonodactylus* il vit dans des galeries creuses de la partie morte des coraux. La disposition morphologique particulière des épines distales du premier article de l'exopodite de l'uropode correspond sans doute à un comportement particulier en relation avec cet habitat. Les antennes et antennules très courtes, les soies des pales antennaires et de l'uropode rares, fortes et non plumeuses comme dans la plupart des autres espèces, les houppes branchiales sur les pléopodes très réduites; enfin la I° patte thoracique (nettoyeuse) avec une disposition particulière me paraissent un ensemble de faits correspondant à un comportement particulier à l'espèce.

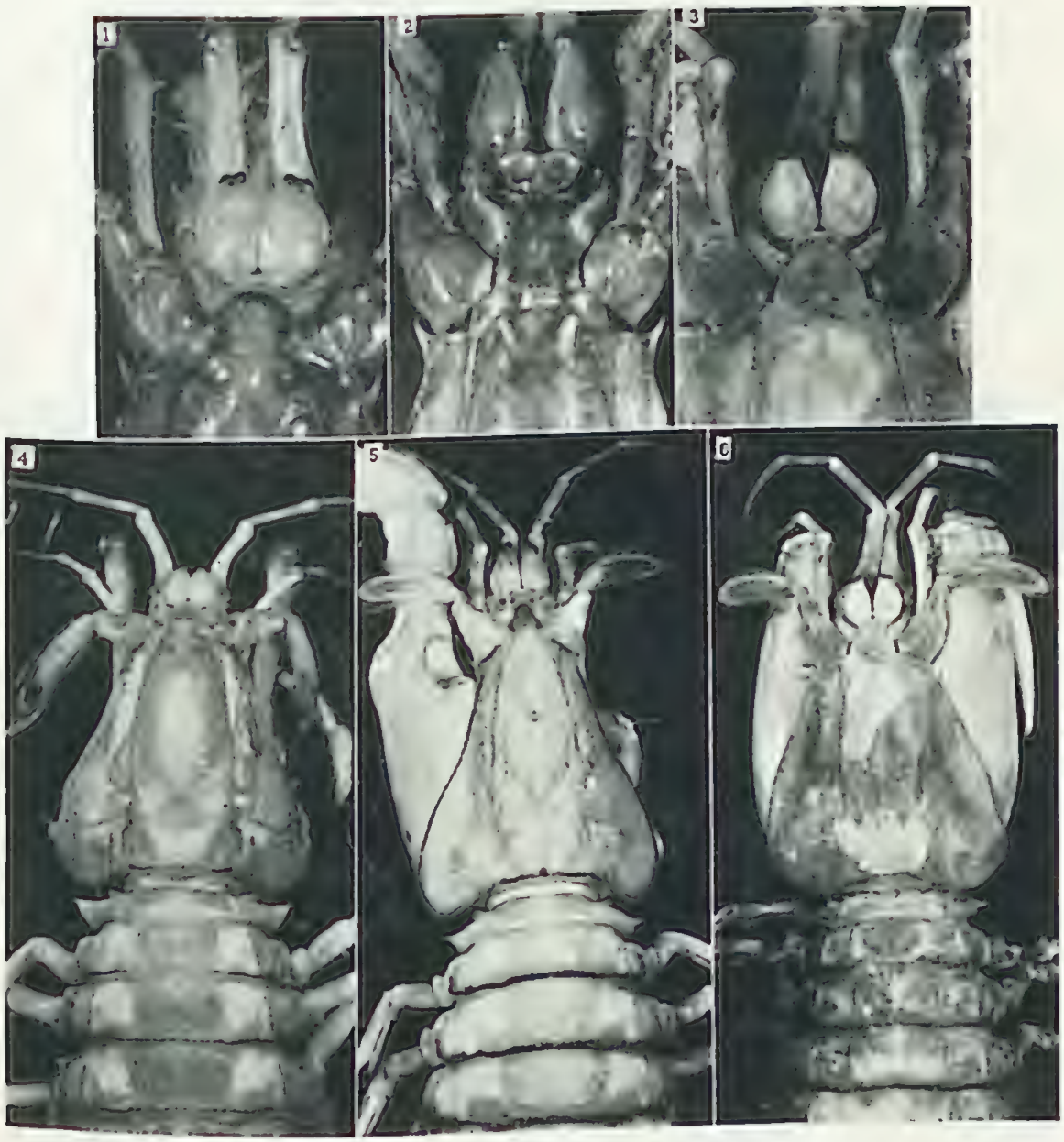
Les specimens de la collection (P. 10.372) ont été récoltés aux îles (Cayes) Nord Ouest du groupe du Capricorne (Queensland).

Gonodactylus tweediei, sp. nov.

Diagnose.—

Yeux.—Les yeux sont cylindriques; la cornée, légèrement aplatie dorso ventralement, est marquée par un sillon longitudinal. Le pédoncule oculaire présente un léger rétrécissement en arrière de la cornée dans sa partie distale qui est plus étroite que sa partie proximale. La cornée est légèrement plus large que le pédoncule oculaire ou égale à sa largeur proximale. Les prolongements dorsaux du segment ophthalmique se terminent en deux épines transverses qui sont visibles de part et d'autre de l'épine médiane du rostre.

Antennules et Antennes.—Les antennules sont courtes et l'extrémité antérieure de la cornée atteint l'extrémité distale du second article du pédoncule antennulaire. La longueur de la pale de l'exopodite antennaire égale les 3/5 environ de la largeur antérieure de la carapace (rapport $\frac{13}{21}$). Il y a un palpe mandibulaire.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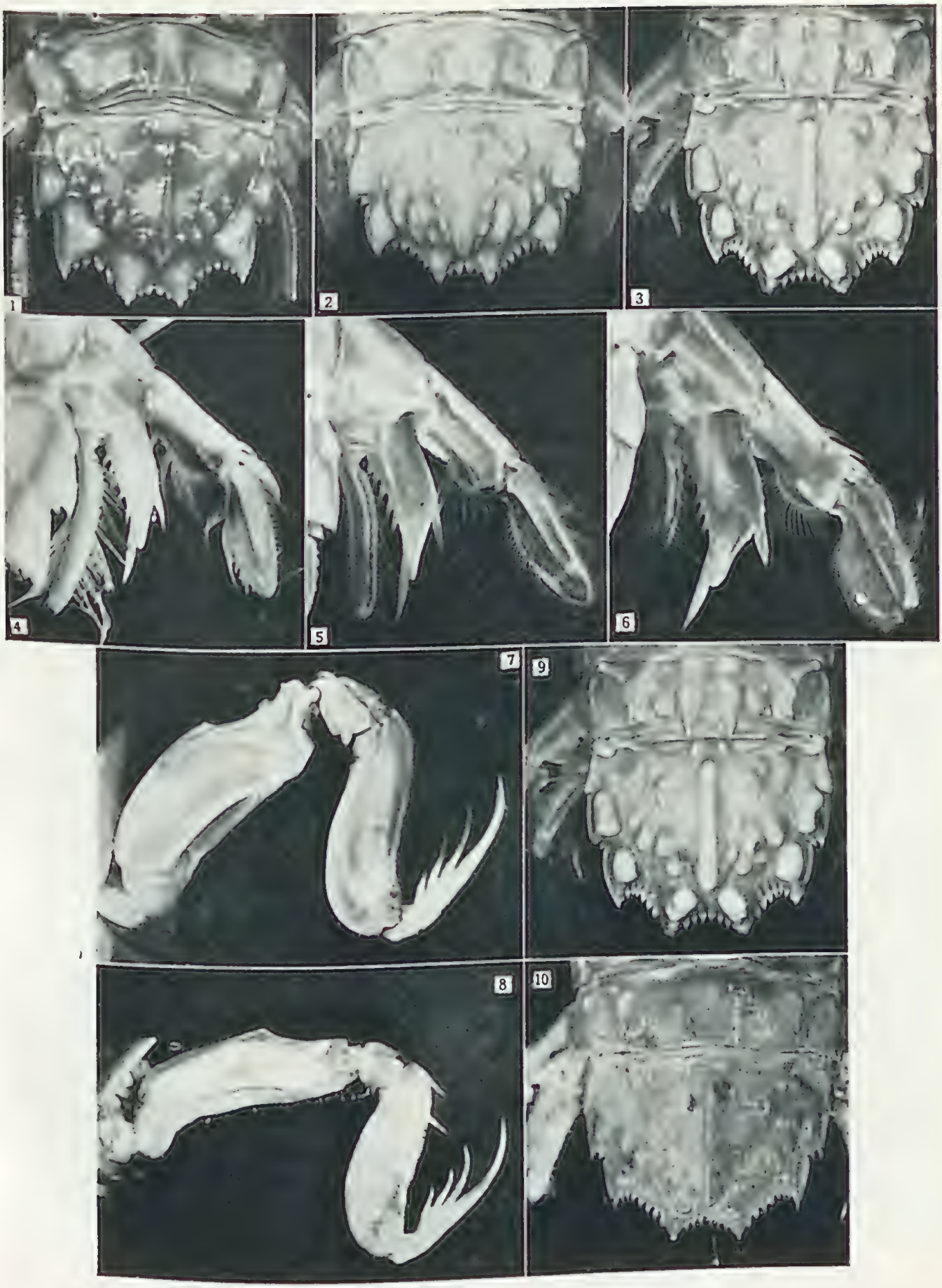
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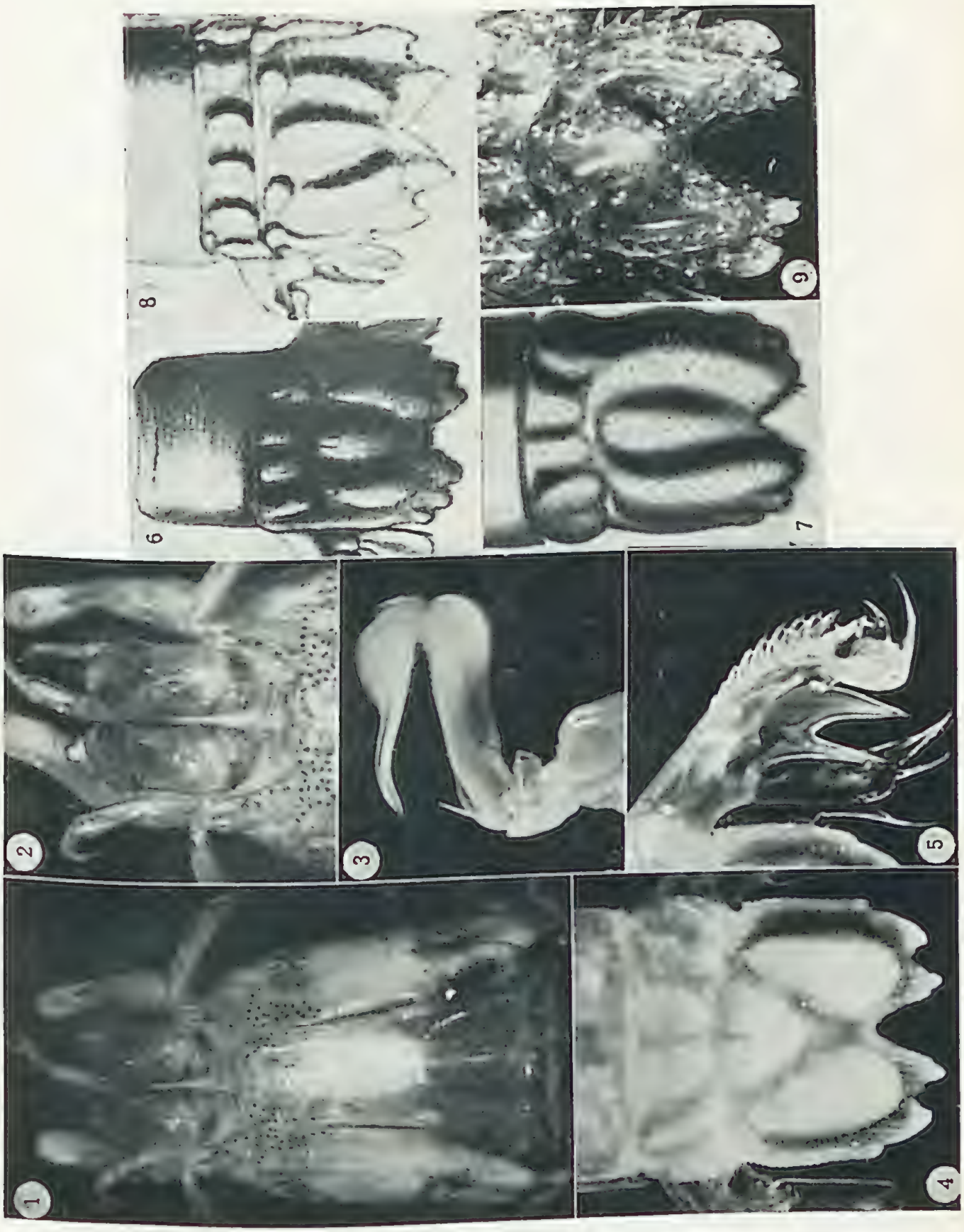
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Rostre.—Le rostre est à trois épines aigues. L'épine médiane, relevée vers le haut à la pointe, porte une carène ventrale et repose antérieurement entre les deux prolongements dorsaux du segment ophthalmique; elle atteint le milieu des pédoncules oculaires. Les épines antéro latérales sont plus courtes et leurs extrémités atteignent juste le niveau de la base des pédoncules oculaires et sont extérieures à son bord externe; les bords latéraux du rostre fortement convexes convergent vers l'arrière; la largeur du rostre au niveau des épines antéro latérales étant beaucoup plus grande qu'au niveau de son articulation avec la carapace (dans le rapport : $\frac{28}{18}$). La partie indivise du rostre est très courte.

Carapace.—La carapace un petit peu plus longue que large, légèrement plus étroite antérieurement que postérieurement, est trapèzoidale. Le bord antérieur est droit, les angles antéro latéraux quadrangulaires faiblement arrondis; les bords latéraux presque droits sont très faiblement concaves et légèrement divergeants en arrière. Les sillons gastriques sont parallèles aux bords latéraux. Le bord postérieur est concave, sa partie médiane correspondant à l'aire gastrique est légèrement en creux par rapport aux angles postéro latéraux qui sont arrondis.

Patte ravisseuse.—Sur le dactyle, le renflement de la partie proximale est très développé et son bord externe présente une encoche très profondément marquée; son extrémité distale est recourbée et son bord interne est finement denticulé. Le propodus présente dans sa partie distale de fines denticulations en épines aigues (plus nombreuses sur le côté externe de son bord interne) et dans sa partie proximale d'autres denticulations peu nombreuses et émoussées auxquelles répondent des creux sur la partie correspondante du bord interne du dactyle. Le propodus porte, en outre, à l'extrémité proximale de la fente, où vient se loger l'extrémité distale du dactyle replié, une forte et longue épine mobile; cette épine existe généralement sur les *Gonodactylus*, mais elle n'est jamais aussi développée. Les cinq premiers appendices thoraciques portent chacun un épipodite.

Segments.—Les trois derniers segments thoraciques et les quatre premiers abdominaux sont lisses et ne présentent rien de très particulier par rapport à ceux des autres espèces de *Gonodactylus*. Les angles postéro latéraux des trois premiers sont quadrangulaires arrondis, ceux du quatrième sont aigus. Le cinquième segment abdominal lisse dans sa partie médiane présente sur ses côtés deux sillons longitudinaux qui séparent trois carènes différemment développées. Sur le bord antérieur du segment le premier sillon en partant de l'intérieur est à peine marqué et ne sépare de la partie médiane du segment qu'une très légère élévation qu'on ne peut pas qualifier de carène. Ce sillon ne marque que la moitié antérieure du segment et on n'en trouve pas de trace sur le bord postérieur du segment. Le deuxième sillon longitudinal, plus fortement marqué sur le bord antérieur, l'est encore davantage sur le bord postérieur; il délimite à la surface de la moitié postérieure du segment un renflement (carène épaissie mais nette) qui correspond en arrière au bord interne de la carène latérale du sixième segment abdominal. Le troisième sillon sépare un autre renflement (carène latérale épaissie) qui se termine postérieurement en pointe émoussée correspondant an arrière au bord externe de la carène latérale du sixième segment; il y enfin sur le bord latéral extrême une carène marginale habituelle qui n'atteint pas le bord postérieur du segment.

Le sixième segment est un petit peu plus long sur les côtés que dans le milieu; il est comme le telson recouvert de soies courtes en brosse comme de fines épines qui lui donne un aspect un peu semblable à celui de certaines autres espèces de *Gonodactylus*, comme *G. tuberosus* par exemple, mais sur *G. tweediei* les soies sont plus longues. La surface du sixième segment porte trois paires de renflements longitudinaux, une submédiane, une intermédiaire, une latérale; la première paire est la plus courte; les renflements

des deux paires médianes sont très arrondis, ceux des troisièmes plus ou moins triangulaires, à arêtes latérales plus ou moins aigues et à extrémité postérieure en pointe non aigue.

Uropode.—Le prolongement ventral bifurqué de l'article basal de l'uropode très robuste a une épine interne légèrement plus courte que l'externe. L'article basal de l'uropode porte à son bord distal une forte épine dorsale légèrement tournée vers l'intérieur. Le premier article de l'exopodite de l'uropode porte sur son bord externe assez fortement convexe dix épines mobiles de taille croissante de la proximale à la distale; le second article, en forme de pâle presqu'aussi large que longue, est court et bordé de soies; sa longueur ne dépasse guère la moitié de celle du premier article mesurée dans son axe; l'extrémité de l'exopodite ne dépasse pas celle de la plus grande épine (externe) du prolongement bifurqué. L'endopodite de l'uropode est bordé de soies; sa largeur est environ le tiers de sa longueur (rapport 7/24).

Telson.— Le telson légèrement plus large que long est comme le sixième segment abdominal recouvert de fines soies courtes en brosses comme de fines épines. Sa surface dorsale porte trois fortes élévations, une médiane et deux latérales; la médiane courte subtriangulaire presqu'hémisphérique la partie (pointe) arrondie vers l'arrière ne dépasse guère le tiers antérieur de la longueur totale du telson; les latérales en forme de poire très arrondies en arrière s'étendent du bord antérieur presque jusqu'au bord postérieur. Le bord postérieur porte une profonde et large excavation médiane qui pénètre en avant du niveau postérieur des élévations latérales; elle est plus large que longue et ses deux bords garnis de spinules longues et minces aboutissent à la dent submédiane émoussée; cette dent porte sur son bord interne et un peu avant son extrémité une forte épine mobile recourbée vers le haut qui se distingue nettement des autres spinules. A l'extérieur de la dent submédiane on rencontre une dent intermédiaire assez forte à pointe arrondie et légèrement courbée vers le milieu et une dent latérale nette mais également arrondie. Entre la dent submédiane et l'intermédiaire on trouve la trace de deux denticles intermédiaires, mais très émoussés. Les bords latéraux ont une carène latérale nette se terminant en arrière à la dent latérale.

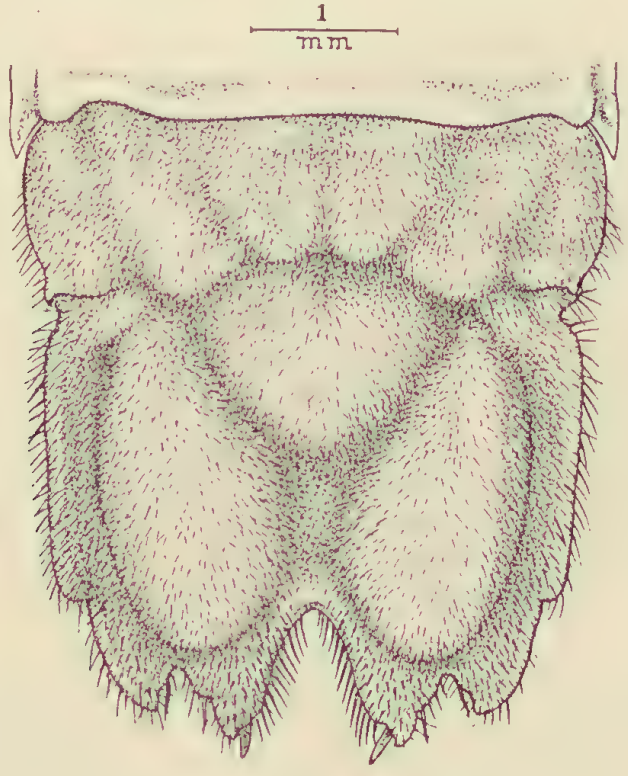

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Fig 33.. *Gonodactylus tweediei*, sp. n.—Telson et sixième segment abdominal, mâle de 24 mm. (P. 10.340) x 15.

Coloration.—Sur les specimens conservés à l'alcool, la coloration est jaune mêlé de gris : des rangées transverses de chromatophores marquant des bandes plus sombres; il y a une bande nette sur la partie antérieure de la carapace et une sur sa partie postérieure et une aussi sur presque tous les segments sauf le sixième abdominal et le telson. Les pédoncules oculaires et les articles basaux des antennes portent des chromatophores. La cornée des yeux est noire.

Situation de l'espèce.—Je décris cette nouvelle espèce pour six specimens de la collection dont les mesures figurent dans un tableau joint. Après l'examen des échantillons P.10.805 et P.10.340, Mr. Tweedie a noté : "*Gonodactylus* sp. assez proche de *brooksi*, mais les bosses sur le telson sont couvertes de nombreuses soies courtes et non de spinules; une nouvelle espèce je pense". L'espèce, assez proche de *G. brooksii* comme noté par Mr. Tweedie, se rattache dans le groupe III aux espèces dont la fissure médiane du bord postérieur du telson est large. Ces espèces comprennent des formes nettements spinuleuses : *G. spinosissimus* Pfeffer, *G. brooksi* De Man, et *G. hystrix* Nobili et d'autres non spinuleuses : *G. excavatus* Miers, *G. tuberculatus* Borradaile. *G. trigibbosus* Hansen, *G. folini* Milne-Edwards. La nouvelle espèce *G. tweediei* plutôt que de *G. brooksii* et des espèces spinuleuses se rapproche davantage de ces dernières formes.

Toutes les espèces de *Gonodactylus* du groupe III ont entre elles une parenté morphologique certaine dont seule l'étude permettra de préciser la situation respective de chacune des espèces. On ne peut guère encore faire cette étude dans l'état rudimentaire de nos connaissances sur de nombreuses espèces du groupe, dont plusieurs ne sont connues que par un seul specimen; presque toutes sont de petite taille et, il faut attirer l'attention sur la difficulté de juger dans certains cas si on a affaire à une espèce adulte ou à une forme intermédiaire entre la larve et l'adulte. De toute manière il convient en situant *G. tweediei* dans le groupe III de le rapprocher aussi bien des espèces à fissure médiane du bord du telson étroite que de celles à fissure médiane large (les spinuleuses et les autres). Pour faciliter ce rapprochement, je donne une clé de détermination de *Gonodactylus* du groupe III, modifiée et complétée d'après celle de Kemp (1913).

GROUPE III.

Angles antéro latéraux de la carapace non en avant de la base du rostre; partie médiane du bord postérieur du dernier segment abdominal concave en vue dorsale; second article de l'exopodite de l'uropode articulé sur l'extrémité distale du premier.

A —Bord distal du telson divisé par une fissure médiane étroite en deux paires droite et gauche dont les bords sont partiellement en contact.

. . . . . *G. pulchellus* Miers 1880.
. . . . . *G. nefandus* Kemp 1911.
. . . . . *G. proximus* Kemp 1915.
. . . . . *G. trispinosus* Dana 1852.
. . . . . *G. tuberosus* Pocock 1893.
. . . . . *G. hamifer* Odhner 1923.
. . . . . *G. pulcher* Hansen 1926.
. . . . . *G. lenzi* Holthuis 1941.
. . . . . *G. tanensis* Fukuda 1911.
. . . . . *G. stoliurus* Muller 1886.
. . . . . *G. ectypus* Muller 1886.
. . . . . *G. glyptocercus* Wood-Mason 1875.
. . . . . *G. gyrosus* Odhner 1923.

A'—Bord distal du telson divisé par une excavation large et profonde en deux moitiés droite et gauche.

B —Bord distal du telson avec de chaque côté de l'excavation médiane deux fortes dents aigues sixième segment abdominal et telson glabre.

. . . . . *G. excavatus* Miers.
. . . . . *G. tuberculatus* Borradaile.

B'—Bord distal du telson avec trois paires de dents marginales aigues; de nombreux piquants et de courtes soies sur les bosses et carènes du sixième segment abdominal et du telson.

. . . . . *G. trigibbosus* Hansen.

B"—Bord distal du telson avec de chaque côté de l'excavation médiane trois dents larges et émoussées.

C —Surface du sixième segment abdominal sans spinules ou épines.

D —Surface du sixième segment abdominal et du telson plus ou moins pubescente : élévation médiane du telson allongée.

. . . . . *G. folini* Milne-Edwards.

D′—Surface du sixième segment abdominal et du telson avec de longues soies en brosses; élévation médiane du telson courte.
. . . . . *G. tweediei* sp. nov.

C′—Surface du sixième segment abdominal et du telson couverte des spinules.

E —Telson avec trois bosses piriformes et des spinules fortes.
. . . . . *G. brooksi* De Man.

E′—Telson avec trois bosses circulaires et des spinules à pointe recourbée en arrière.
. . . . . *G. hystrix* Nobili.

C″—Surface du sixième segment abdominal et du telson couverte avec de longues épines.
. . . . . *G. spinosissimus* Pfeffer.

Quelques remarques préciseront la valeur relative de certains caractères de cette clé :

1°—Dans la section A—les espèces *G. lenzi*, *G. tanensis*, *G. stoliurus*, *G. ectypus*, et *G. glyptocercus* présentent une fissure médiane légèrement plus large et de forme intermédiaire en quelque sorte entre celle des autres espèces de la section A et celles des espèces de la section A′, en particulier les premières : *G. excavatus*, *G. tuberculatus*, *G. trigibbosus*, *G. folini*, *G. tweediei*.

2°—Dans la plupart de ces espèces sans doute (je n'ai observé le fait pour le moment que dans *G. lenzi* et *G. glyptocercus*) l'écartement de la fissure varie avec l'âge; il est plus grand dans les formes jeunes; et il existe entre les larves et l'adulte des formes jeunes intermédiaires à ce sujet. Une telle forme intermédiaire de jeune *G. glyptocercus* par exemple, est très proche de *G. excavatus*. Si Hansen (1895) a pu rapporter à *G. stoliurus*, du groupe A, des specimens que Miers (1880) avait rapporté à *G. folini* du groupe A′, c'est sans doute que ce caractère n'est pas toujours très net. On doit admettre que le caractère distinctif de l'écartement de la fissure médiane n'a sa valeur que sur les adultes.

3°—Dans la section A′, les espèces de la section B, *G. excavatus*, et *G. tuberculatus* se séparent de celles de la section B′, outre par le nombre des dents du bord postéro latéral du telson, par l'aspect glabre de leur telson; les espèces de la section B′ sont toutes plus ou moins pubescentes sur le telson. Cette pubescence, réduite dans *G. trigibbosus* (où elle est mêlée de piquants), mal définie dans *G. folini*, est très développée dans *G. tweediei*. Je ne pense pas que ce caractère puisse être en relation avec l'âge et je crois qu'on peut le considérer comme valable.

4°—Le caractère des dents du bord postéro latéral du telson parait aussi très valable; Hansen (1926) quand il crée *G. trigibbosus* précise que, si l'espèce est proche de *G. folini*, elle s'en distingue en particulier par les trois paires de dents marginales du telson qui sont aigues et non émoussées comme dans *G. folini ;* par ce dernier caractère *G. tweediei* est très proche de *G. folini*.

G. tweediei se sépare de *G. brooksii* sans aucune difficulté et je donne une photographie du telson de *G. brooksii* qui le montre bien. Par contre il est très proche de *G. trigibbosus* et surtout de *G. folini*. Il parait utile pour préciser sa situation par rapport à ces espèces mal connues de donner quelques informations à leur sujet.

G. trigibbosus—Hansen (1926) décrit cette nouvelle espèce pour un seul specimen du Siboga de 14 mm., 5 de long et elle n'a jamais été retrouvée. Hansen donne une très bonne description de son specimen dont certains caractères sont très proches de ceux du *G. tweediei*, en particulier l'aspect général de la surface du telson. Hansen écrit : " Le telson est faiblement plus large que long et quelque peu dépressé. L'excavation marginale postérieure est large, triangulaire, considérablement plus large que longue et ses extrémités aigues ont une petite épine mobile, tandis que les bords internes de chaque dent ont un bon nombre de denticles fins et minces. Les dents intermédiaires sont bien développées, considérablement plus larges que longues, aigues et une paire de denticles est visible dans l'excavation entre les dents submédianes et intermédiaires. Les dents latérales sont petites mais très nettes triangulaires et aigues.

La surface porte trois grandes bosses longitudinales; la bosse médiane est très ovale oblongue ou mieux ovale triangulaire avec les angles bien arrondis; elle commence presqu'à la base du telson et se termine quelque peu en avant du fond de l'excavation marginale médiane. Les bosses intermédiaires sont plutôt épaissies que considérablement plus étroites que la médiane; elles atteignent postérieurement presque la base de la grande dent submédiane; antérieurement on peut dire qu'elles atteignent presque la base du telson, mais la partie proximale de chaque bosse est marquée d'un noeud haut, arrondi, quelque peu oblique, séparé par une dépression transverse. Les bords latéraux ont une carène nette atteignant la dent latérale, et entre cette carène et la bosse intermédiaire la surface montre une carène submarginale faiblement développée. Les bosses et carènes ont de nombreux piquants avec de courtes soies". De nombreux points de cette description, comme de celle du sixième segment abdominal concordent parfaitement avec ceux de *G. tweediei*; mais *G. tweediei* se sépare de cette espèce par: (*a*) le rostre triépineux aigu alors qu'il est à dents latérales courtes, très large avec extrémités subaigues dans *G. trigibbosus*; (*b*) les bosses latérales du telson ne présentant pas de protubérance séparée comme dans *G. trigibbosus*; (*c*) la bosse médiane du telson est plus courte; l'expression d'Hansen (1926) pour *G. trigibbosus*: " ovale triangulaire avec les angles très arrondis " définit bien la forme de la bosse médiane de *G. tweediei*; par contre elle correspond mal à celle de *G. trigibbosus* telle qu'elle est figurée par Hansen (1926, pl. I, fig. 5); (*d*)—tout le telson et le sixième segment abdominal couverts de longues soies rigides au lieu que ceux de *G. trigibbosus* ne portent que de nombreux piquants et de courtes soies sur les bosses et carènes; (*e*)—les trois paires de dents marginales du telson arrondies et non aigues comme dans *G. trigibbosus*; (*f*)—le telson très étroitement soudé au sixième segment abdominal et non mobile par rapport à lui comme dans *G. trigibbosus*.

Gonodactylus folini—Milne Edwards (1868) décrit l'espèce pour un specimen de 20 mm. recueilli au Cap St. Vincent par M. Muller et offert au Muséum de Paris par M. De Folin. Miers (1880) signale un mâle de l'ile Maurice et deux petits specimens de la collection " Herald " sans précision d'origine, que Hansen (1895) qui les réexamine rapporte à *G. ectypus* Muller. Brooks (1886) cite l'espèce dans ses *Protosquilla* sans signaler de specimen, et crée une nouvelle espèce *G. elongata* très voisine. Hansen (1895) cite des specimens jeunes, et d'une part supprime le genre *Protosquilla*; d'autre part il fait entrer la *P. elongata* Brooks en synonymie avec *G. folini*. Bouvier (1905) signale quatre exemplaires de Praia das Conchas (ile San Thomé, Golfe de Guinée). Kemp (1913) sans examiner de specimen fait seulement remarquer que l'espèce est uniquement atlantique et très voisine de *G. excavatus*. Balss (1916) cite sans commentaire un specimen; Parisi (1921) cite sans commentaire trois specimens du Cap-Vert provenant du Musée de Paris. Gravier (1927) signale du Cap St. Vincent récoltés par 'Le Talisman' 62 exemplaires sans les décrire. Si l'on excepte les nombreux spécimens de Gravier (1927), on ne connait donc qu'un très petit nombre d'exemplaires et les observations des auteurs sur cette espèce sont assez rudimentaires; je crois nécessaire d'en reproduire ici l'essentiel.

Milne Edwards (1898) ne donne qu'une diagnose sommaire. " La plaque rostrale est armée d'une épine médiane, étroite et beaucoup plus longue que celle du Gonodactyle goutteux[7]; de chaque côté se trouve une autre épine dirigée en dehors et en avant. Le doigt des pattes ravisseuses est très renflé à sa base, terminé par une extrémité aigue et dépourvu de dents sur son bord préhensible. Les anneaux de l'abdomen sont lisses, leur bord est arrondi et sans découpures. Les derniers articles sont complètement différents de ceux du Gonodactyle goutteux[7]. Le sixième et le septième, au lieu d'être libres, sont soudés en une seule pièce; la partie antérieure correspondant au sixième anneau porte quatre tubercules arrondis, dont les externes sont divisés en trois lobes.

7. *G. chiragra.*

La partie postérieure correspondant au 7è article présente, de chaque côté, un renflement longitudinal un peu réniforme à convexité externe; sur la ligne médiane il existe un troisième renflement, impair et moins élevé que les précédents. En arrière, le bord de l'article est échancré au milieu et découpé latéralement en trois dents obtuses et arrondies."

Bouvier (1905) précise deux nouveaux caractères : un sur la coloration de la carapace, l'autre sur la pubescence du telson. Il écrit : " Coloration assez variable sur le vivant : les deux derniers exemplaires avaient une teinte brun chocolat sur le céphalothorax et la partie suivante de couleur grise; les deux autres specimens présentaient une teinte jaune d'ambre avec une bande horizontale claire sur le céphalothorax. Cette bande est probablement consistante, car on l'observe encore sur tous les exemplaires, même dans l'alcool. La pièce formée par la soudure des deux derniers segments abdominaux est toute couverte d'une pubescence presque laineuse qui n'est pas signalée dans le type, d'ailleurs desséché, qui servit à Milne-Edwards."

Kemp (1913) remarque que *G. folini* se distingue de *G. excavatus* en ayant une excavation médiane moins profonde et bordée de soies et non de denticles sur ses bords comme *G. excavatus ;* d'autre part les dents du bord postérieur sont arrondies sur *G. folini* alors qu'elles sont aigues dans *G. excavatus.*

L'Iconographie de l'espèce est insuffisante, les quatre dessins de Milne-Edwards (1868) étant assez imprécis. La figure d'Hansen (1895, pl. viii, fig. 6) d'après le specimen de Milne-Edwards est bien meilleure; et il convient d'ailleurs d'insister sur les observations d'Hansen (1895). La découverte d'une forme intermédiaire entre la larve et l'adulte qu'il rapporte à *G. folini* permet à Hansen de montrer que le caractère de soudure du sixième segment et du telson est secondaire et l'amène à supprimer le genre *Protosquilla* Brooks. Si j'adopte avec tous les auteurs cette manière de voir; je conserve un doute sur l'exactitude de la détermination qui fait rapporter à *G. folini*, la forme intermédiaire (Pl. VIII, fig. 7) d'Hansen. Cette réserve n'enlève rien à la valeur des précisions qu'Hansen apporte sur *G. folini* d'après le specimen type de Milne-Edwards qu'il examine au Museum d'Histoire Naturelle de Paris. Hansen ne signale pas la pubescence du 6è segment et du telson de *G. folini*, mais dans le dessin qu'il donne de l'espèce d'après le type de Milne-Edwards, il la figure. Milne-Edwards ne signale pas cette pubescence. Pour *P. elongata* qu'Hansen fait entrer en synonymie avec *G. folini* Brooks (1886) écrit : " la surface du corps est fortement polie à l'exception du sixième segment abdominal, du telson et des uropodes qui sont (rough) rugueux." Bouvier (1905), qui le premier la remarque sur *G. folini* la définit comme " presque laineuse". Le caractère de soudure étroite du 6° segment abdominal avec le telson de *G. folini* se retrouve chez *G. tweediei ;* et les deux espèces sont si proches qu'on peut considérer sans doute *G. tweediei* comme une forme Pacifique correspondant à la forme Atlantique *G. folini.*

J'ai insisté sur *G. folini* pour mieux montrer la valeur relative des caractères distinctifs entre *G. tweediei* et cette espèce que je vais donner; l'examen comparatif d'exemplaire de *G. folini* permettra seul de les confirmer. Ma diagnose définit suffisamment *G. tweediei* pour qu'un tel travail puisse être étendu à d'autres caractères.

G. tweediei se distingue de *G. folini* par : 1°—l'épine mobile du propodus de la patte ravisseuse bien développée; elle n'est pas signalée sur *G. folini*, 2°—l'élévation médiane du telson courte et ovale triangulaire alors qu'elle est ovale allongée dans *G. folini*, 3°—la couverture de soies rigides du sixième segment abdominal et du telson; elle est moins développée sur *G. folini.*

Les specimens de *G. tweediei* ont été récoltés :

P. 10.070 — Aux îles (Cayes) Nord-Ouest du Groupe du Capricorne (Queensland).

P. 10.805 — Sur le Récif Elizabeth, au Nord de l'île de Lord Howe (Sud Pacifique).

P. 10.340 — Dragué par 4 brasses (7 m 30) de fond dans le détroit Erskine de l'île de Lord Howe (Sud Pacifique).

P. 5.273 — Ile de Lord Howe (Sud Pacifique).

Gonodactylus tweediei.

		Corps.	Rostre.		Oeil.				Carapace.			Segments.		Telson.	
Numéros d'Echantillons.	Sexe.	Longueur totale yeux compris.	Longueur.	Largeur à la base.	Longueur pédoncule antennulaire.	Longueur de l'oeil.	Largeur de la cornée.	Indice de cornée.	Largeur antérieure.	Largeur postérieure.	Longueur rostre exclus.	Largeur 5è segment thoracique.	Largeur 5è segment abdominal.	Plus grande largeur.	Plus grande longueur.
P–10340	♂	24	1·8	1·5	4	2·5	1·2	4·40	3·5	4	5·3	3	4	4	3·8
P–10805	♂	22·5	1·5	1·2	3	2	1	4·50	3	3·5	4·5	3	3·5	3·7	3·6
P–5273a	♀	26·5	2	1·7	4	2·5	1·2	4·58	3·5	4	5·5	3·5	4·2	4	3·8
P–5273b	♀	24·5	1·7	1·5	3·5	2·2	1·2	4·16	3·5	4	5	3·5	4	3·8	3·7
P–10070	♀	22·5	1·5	1·2	3	2	1	4·50	3	3·8	4·5	3	3·5	3·5	3·3
P–5273c	♀	21	1·5	1·2	2·8	1·8	1	4·00	3	3·5	4	2·8	3·5	3	2·8

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* Les ouvrages marqués d'une asterique (*) sont particulièrement consacrés aux Stomatopodes d'Australie.

EXPLANATION OF PLATES I–III.

PLATE I.

Yeux et Rostre—

Fig. 1. *Squilla latreillii* ♂ de 63 mm. (E. 9559) x 4·62.
Fig. 2. *Squilla microphthalma* ♂ de 75 mm. (E. 8821) x 4·44.
Fig. 3. *Squilla depressa* ♂ de 86 mm. (E. P.5614) x 3·28.

Partie Antérieure et Segment Thoracique—

Fig. 4. *Squilla latreillii* ♂ de 85 mm. (E. 4003) x 1·86.
Fig. 5. *Squilla microphthalma* ♂ de 85 mm. (E. 9163) x 1·92.
Fig. 6. *Squilla depressa* ♂ de 86 mm. (E. P.5614) x 1·8.

PLATE II.

Telson & Uropode Droits—

Telson—

Fig. 1. *Squilla latreillii* ♂ de 63 mm. (E. 9559) x 2·7.
Fig. 2. *Squilla microphthalma* ♂ de 85 mm. (E. 9163) x 2·1.
Fig. 3. *Squilla depressa* ♂ de 86 mm. (E.P. 5614) x 2·1.

Uropode—

Fig. 4. *Squilla latreillii* ♂ de 63 mm. (E. 9559) x 3.
Fig. 5. *Squilla microphthalma* ♂ de 85 mm. (E. 9163) x 3.
Fig. 6. *Squilla depressa* ♂ de 86 mm. (E. P.5614) x 3·6.

Dimorphisme Sexuel de *Squilla depressa* Miers 1880—

Fig. 7. Patte ravisseuse droite d'un ♂ de 86 mm. (E. P.5614) x 2·4.
Fig. 8. Patte ravisseuse droite d'une ♀ de 77 mm. (E. P.10934) x 2·7.
Fig. 9. Telson d'un ♂ de 86 mm. (E. P.5614) x 2·1.
Fig. 10. Telson d'une ♀ de 77 mm. (E. P.10934) x 2·7.

PLATE III.

Gonodactylus tweediei sp. nov. (P 10.340) mâle de 24 mm. de long, (P. 5.273) femelle de 26 mm., 5 de long—

Fig. 1. *Partie antérieure* : Les antennules et antennes, les yeux, la carapace (P. 10.340) x 8.
Fig. 2. *Yeux et rostre* : La cornée et le pédoncule oculaire (P. 10.340) x 10·4.
Fig. 3. *Patte ravisseuse gauche* : Face interne montrant l'épine sur le propodus (P. 5.273) x 10·4.
Fig. 4. 6è *segment abdominal et telson* : (P. 10.340) x 10·4.
Fig. 5. *Uropode droit* : L'endopodite, le prolongement bifurqué de l'article basal, l'exopodite (P. 10.340) x 10·4.

Telson—

Fig. 6. *Gonodactylus folini* d'après Milne Edwards 1868, Pl. XVIII, fig. 10.
Fig. 7. *Gonodactylus folini* d'après Hansen 1895, Pl. VIII, fig. 6.
Fig. 8. *Gonodactylus trigibbosus* d'après Hansen 1926, Pl. II, fig. 5b.
Fig. 9. *Gonodactylus brooksii.* ♀ de 30 mm, 5 (E- 1888) x 5·6.

TWO NEW SCORPION FISHES FROM QUEENSLAND.

By Gilbert P. Whitley, F.R.Z.S.,
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(Figures 1–2.)

The use for the first time of prawn- and otter-trawls in southern Queensland bays in recent years has yielded some interesting fishes which escaped the notice of fishermen and naturalists employing more familiar methods of collecting. Perhaps the most remarkable-looking of these novelties are the various Scorpion Fishes which lurk amongst rocks or weeds, resembling their surroundings, and provided with venomous spines for attack or defence. These Scorpaenidae may be very local in distribution and are specialised, or even grotesque, in shape.

Through the courtesy of the Secretary and Chief Administration Officer of the Department of Harbours and Marine, Brisbane (Mr. E. Coulter) and the Government Ichthyologist (Mr. T. C. Marshall), I have been enabled to examine and report upon two very interesting specimens which are evidently new to science, and which are accordingly named below.

Family SCORPAENIDAE.

Peristrominous, gen. nov.

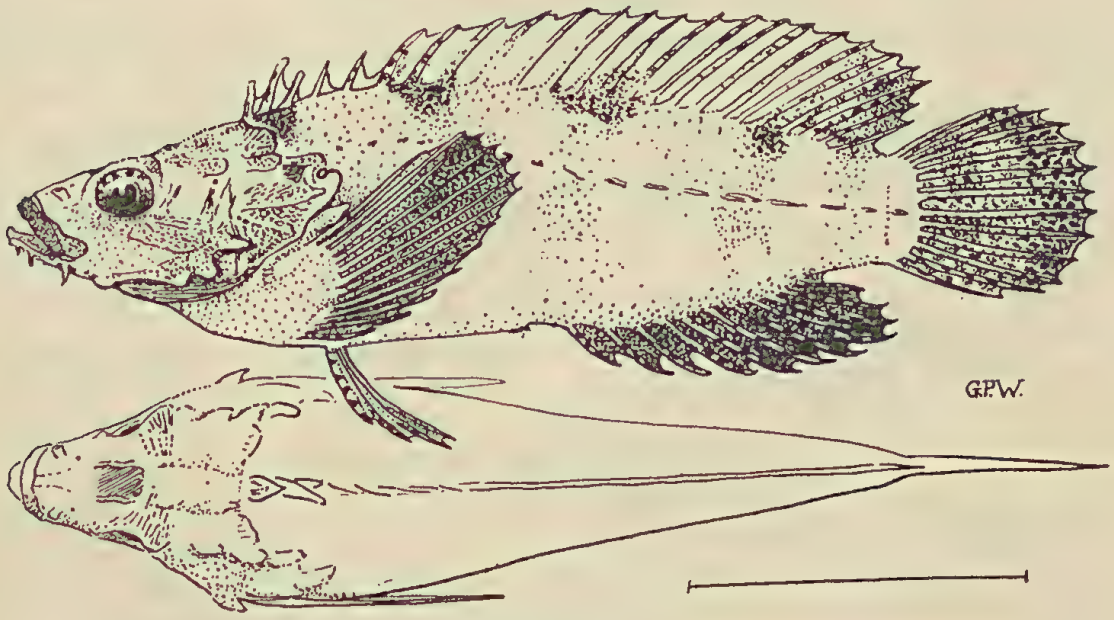
Orthotype, *P. dolosus*, sp. nov.

A genus of Scorpion Fishes with the head armoured with rugose bones without sharp spines; the body scaleless, papillose. Less than eight dorsal spines. All fin-rays simple. No free pectoral rays. V. i, 3. The dorsal fin begins well behind the level of the eyes.

The foregoing characters differentiate the new genus from others in the family, but the position of the first dorsal origin suggests that it is intermediate between Scorpaenidae and Aploactidae.

Latin *peristroma*, a carpet, and *Minous*, a related genus of fishes.

Peristrominous dolosus, sp. nov.



(Figure 1.)

D. iii/iv, 17. A. 11. P. 13. V. i, 3. C. 13. L.lat. with 16 or 17 tubes.

Three stumpy, papillose barbels on each side of chin, enclosing two small ones behind a median pit. Mouth terminal, oblique, small, lips thick and papillose, not quite reaching eye. Broad pads of velvet-like teeth in jaws and perhaps on vomer, but so weak as to be imperceptible. Breadth of head subequal to predorsal length, greater than depth of head, the latter being conic, depressed above and below, with swollen cheeks, all stoutly armoured with rugose bones. Two blunt preopercular, two opercular and one humeral spine on each side, otherwise the head lacks spines or ridges, having only bony bosses, a pitted suborbital stay, and entire preorbital. Middle of interorbital with a sunken, naked, rectangular depression. Nape not excavated like a saddle. Eyes oval, superolateral. Anterior nostril with prominent cup-shaped rim; posterior one a simple pore. Gill-membranes united in advance of or overlying isthmus which flaps over the vestibule so formed. Gill-openings very wide. A slit behind fourth arch. Four or five soft, knob-like gill-rakers on lower part of first gill-arch. No pseudobranch. Gill-chamber with raised posterior bony rim.

Head (22 mm.) nearly 3, depth (19) 3·4 in standard length (65). Eye (5) equals snout (5), less than interorbital (nearly 7) or depth of caudal peduncle (8). Predorsal length (18) more than breadth of body (16).

Body robust anteriorly, its greatest depth near ventral base, compressed posteriorly, scaleless, the skin papillate. Lateral line with low, ridge-like tubes, running from upper part of operculum steeply down to above middle of side between soft dorsal and anal fin and ending at middle of root of tail, without flaps or filaments. Vent plicate, with a papilla, in advance of anal fin.

Dorsal fin originating well behind level of eye, on nape over operculum. First three spines slightly separate from others, the second longer than first or third, which are very short. The second dorsal fin begins with several low spines which pass imperceptibly into simple, articulated rays, the fourth from the posterior end being longest. Anal similar to soft dorsal, without pungent spines. All the fin-rays are unbranched. Pectoral without free rays, seventh ray longest. Ventrals behind level of head, last two rays longest. Last dorsal ray united by membrane to upper caudal ray; last anal ray well in advance of this level. Caudal truncate, with rounded corners.

Head and body light-brown with darker marblings tending to form four bars descending from back. Belly little lighter. Fins smoky-grey to brownish, variegated; tips of anterior dorsal spines pale; the pectorals and anal very dark; no striking axillary markings. Eye blue, surrounded by dusky radii.

Loc.—Deception Bay, Queensland; taken in prawn-trawl, Mr. A. J. Keong, 1951.

Described and figured from the unique holotype, No. 1013 in the collection of the Department of Harbours and Marine, Brisbane, Queensland. Total length 82 mm. or 3¼ inches.

Suggested vernacular name, Brown Carpet Fish.

Latin *dolosus*, deceitful, partly from its camouflaging coloration and partly from the type-locality, Deception Bay.

Genus **Membracidichthys** Whitley, 1933.

Adventor, subgen. nov.

Orthotype, *M.* (*A.*) *elongatus*, sp. nov.

A fish similar in facies to the Aploactidae, but having the dorsal origin behind the eye as in most Scorpaenidae; the depth is more than 4 in *total* length and eye more than 4 in head.

Evidently an elongate representative of *Membracidichthys* Whitley (Rec.Austr. Mus., xix, 1933, p. 102), but the genotypical species, *obbesi* Weber (Siboga Exped., lvii, Fische, 1913, p. 503, figs. 104 and 105), has steeper profile, shorter form, one more ventral ray, and dorsal originating over middle of eye, the latter not much less than snout in length. *Aniculerosa* Whitley (loc. cit., p. 101) has shorter habit, more ventral rays, and dorsal origin over front of eye.

Latin *adventor*, a visitor.

Membracidichthys (Adventor) elongatus, subgen. & sp. nov.

(Figure 2.)

D. iii, 10, 10. A. 11. P. 14. V. i, 2. C. 4, 10, 2. L.lat. 12.

Depth (25 mm.) 4·05, head (31) nearly 3·4, length of caudal (17) 6 in *total* length (105). Eye (6) 5·1 in head, 2 in snout (12) and equal to interorbital (6). Depth of caudal peduncle, 10 mm.; breadth of body, 16; second dorsal spine, 8; standard length, 87. Predorsal length (19) equals breadth of head, which is slightly more than its depth.

Chin projecting. Profile of head low. Mouth not reaching below the small eye. Villiform teeth on jaws and vomer. Nostril with tube. A barbel overhangs corner of upper lip. Chin with pits and processes like small barbels. Supraorbital sculptured. Three divergent, blunt preorbital spines. Two suborbital spines, behind which the stay crosses to the preoperculum, whose margin has 5 blunt spines. Opercular spine weak. Usual nuchal and occipital ridges, without rugae or spines. Interorbital with pear-shaped, sunken median area, broad end facing the rectangularly excavate nape. Tongue pointed, adnate to floor of mouth. Gill-membranes free of isthmus. Only 5 rudimentary papilla-like gill-rakers on lower part of first gill-arch; no slit behind last gill-arch. No pseudobranch.

Head and body long, compressed, naked of scales but densely covered with velvety papillae which even extend around eye. Lateral line canal running along upper half, following curve of back, and with 12 raised pores. Vent small, plicate, with papilla, in advance of anal fin.

Dorsal originating well behind eye, its first three spines (the second of which is longest) distinct from the fourth and the remainder, the last joined to the higher soft dorsal which joins caudal peduncle. All fin-rays simple. Caudal broadly rounded. No free pectoral rays, 5th and 6th pectoral rays longest. Ventrals below operculum and front dorsal spines.

Colour dark-reddish chocolate-brown, irregularly variegated with paler and darker tones, particularly on the fins. Small dark-brown ocelli give an illusion of pits on top of head, in hollows of nape, and around spinous dorsal fin. No striking axillary markings. Eye blue. Indistinct brown spots along inner posterior margin of gill-opening.

Loc.—Tiflis Passage, Moreton Bay, Queensland. Otter trawl, 3rd June, 1951; T. C. Marshall and G. P. Whitley.

Described and figured from the unique holotype, No. 516 in the collection of the Department of Harbours and Marine, Brisbane. Total length, 105 mm. or $4\frac{1}{8}$ inches.

EPIGENETIC COMMON OPAL FROM THE HAWKESBURY SANDSTONE FORMATION OF THE SYDNEY BASIN

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(Plate IV.)

Abstract.

An unusual occurrence of epigenetic common opal, apparently derived from the normal ground-waters of the Hawkesbury sandstone formation of the Sydney Basin, is described. The opal forms simple and botryoidal incrustations, simple and coralloidal stalactitic structures and also is deposited on stalactites of lamellar limonite. Refractive index values vary widely and haphazardly between 1.414 and 1.443.

In the Hawkesbury sandstone formation of the Sydney Basin small caves and ledges often show groups of stalactites and, more rarely, stalagmites up to 3 cm. in length. An immediate reaction was to class them as being calcereous and derived from the several calcereous members of this formation. Closer study, however, showed they were composed of common opal and as such were of considerably greater interest.

The common opal probably occurs wherever the Hawkesbury sandstones outcrop as, when looked for, they have always been found. The best occurrences yet seen, and the ones described here, were in small caves along the banks of Galna Creek which is west of the main northern railway line between Mount Colah and Mount Kuring-gai stations.

Typically the common opal structures are found on the roofs and floors of small caves but often they are found growing horizontally at 90 degrees to the walls of almost vertical cracks. Often, and particularly where the caves are formed by ledges in a creek bed, the stalactites are wet and apparently still growing. Elsewhere they are quite dry and "dead".

At least four different modes of occurrence can be differentiated :—

I. Simple and botryoidal incrustations.

II. Simple stalactitic structures.

III. Coralloidal stalactitic structures.

IV. Incrustation on lamellar limonitic stalactites.

I. Simple and Botryoidal Incrustations.

Simple (*i.e.*, smooth) incrustations are usually about 1 mm. thick. The botryoida type incrustation is slightly thicker and represents a further stage in deposition as the botryoidal surface is formed by the accentuation of irregularities in the surface by further deposition of material. Both incrustations may grow immediately on the surface of the normal sandstone or else a second zone may develop between the normal sandstone and the common opal. This central zone shows residual quartz grains in white, opaque common opal which has replaced or rather infiltrated and included the clay cement. The process is rather one of infiltration as crushed fragments of the opal are almost opaque due to included clay material. In some cases this central zone is represented by infiltration of limonitic material.

The central zone rapidly gives way to the outer layer of the white, opaque common opal with a resinous lustre and normally hard and homogeneous. Inside any of the larger botryoidal protuberances the centre is composed of dark, earthy material which

is much softer than the outer opal. This is paralleled in the description of opal stalactites by Anderson (1930) from a lava tunnel. He noted that the opal is often only a coating on rather earthy, porous, concentric material. This material was considered by Anderson to represent a more hydrated siliceous material which forms the normal hard outer type by surface dehydration. Similarly this interpretation can be applied to the occurrence in point for, although the circumstances of formation are quite different, the manner of deposition is comparable.

Because of the clean white colour of the outer surface it was thought the material would be reasonably pure and suitable for refractive index studies. Crushed fragments were examined and were found to be contaminated by a considerable amount of extraneous matter (mostly opaque clay-like substances) which had been included by the opaline material as it grew, most likely as settled dust particles.

Clear and comparatively uncontaminated fragments of common opal were used in refractive index determinations. Values obtained from the samples chosen were very variable, ranging from 1.414 to 1.443. This would indicate that the water content of the common opal was also very variable. As the variation in refractive index values is apparently haphazard, so the variable water content would be haphazard and any chemical determination of water would serve no useful purpose.

II. Simple Stalactitic Structures.

A natural development of the botryoidal type of incrustation is the formation of simple stalactites and then stalagmites arising from preferred deposition from the protuberances of the incrustation. As such they show similar structures—a central soft, earthy core with a hard exterior of white, opaque common opal. These simple stalactites are conical, 1.0–1.5 cm. long and 0·2–0·8 cm. diameter at the base.

III. Coralloidal Stalactitic Structures.

A further development in the deposition process is the irregular growth of the stalactites forming "coralloidal" stalactites apparently very similar to those first described by Swartzlow and Keller (1937). This irregular growth in all directions leads to the formation of bulbous and grotesque growths which resemble coral heads. The internal structure is the same as described above.

IV. Incrustation on Lamella Limonitic Stalactites.

Stalactites of lamellar limonite up to 8 cm. long and of elongated section show a unique coating of the hard, white form of the common opal. The incrustation is rather thin but covers quite large areas on the stalactites. One stalactite showed a previously broken end into which the opal had been deposited forming over, but still following, the concentric lamellae of limonite.

ORIGIN.

The presence of wet and still growing stalactites indicates that the depositional processes are still active and the origin of the silica is not difficult to find. Groundwaters are commonly carriers of silica and the slow percolation of water through the typ cal orthoquartzites of the Hawkesbury sandstones would allow appreciable solution of the silica. The deposition of this silica as opal indicates that alkalies are absent from the waters otherwise quartz would have formed preferentially (Clarke 1916). Analyses of water from Hawkesbury sandstone generally show it as slightly acid with alkalies rare, so in that area opal is to be expected as the product of precipitation. Osborne (1948), in discussing the origin of certain silica cements in some members of the

Hawkesbury sandstone formation, also attributes their formation to ground-water action. This would suggest that such cements were formed at a time when the ground-waters were alkaline but present day conditions favour formation of common opal.

The simple incrustations are dry and "dead" and most likely have been so since the time of formation, but the coralloidal growths, which are a later development, together with some simple stalactites, are still forming. It would therefore appear that all types of deposition began about the same time.

The origin of the opaline material differs from that described by Anderson (1930) and Swartzlow and Keller (1937) in being undoubtedly entirely due to precipitation of silica from charged ground-water. These other writers have described the occurrences from lava tunnels in which the opal may have at least partly been formed by deuteric solutions although later ground-water solution and subsequent deposition is considered by Swartzlow and Keller to be still in progress.

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Explanation of Plate IV.

Fig. 1.—Common opal, simple stalactites. D38202 (Australian Museum Mineral Collection Registered Number). x 1½

Fig. 2.—Common opal, coralloidal stalactites. D38205. x 1.

Fig. 3.—Common opal, covering lamellar limonitic stalactites. D38203. x ½.

Photographs by Howard Hughes.

Fig. 1.

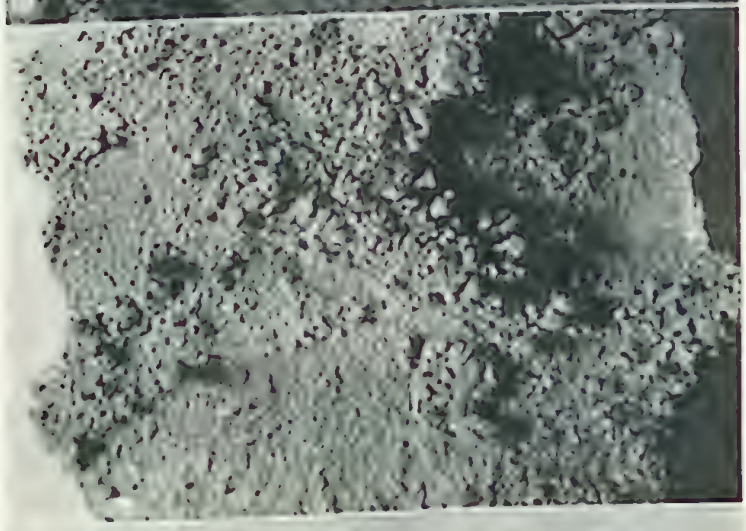

Fig. 2.

Fig. 3.

MINUTE BIVALVES FROM NEW SOUTH WALES.

By Charles Francis Laseron, F.R.Z.S.

Honorary Correspondent, Australian Museum.

(Figures 1–44.)

Introduction.

This paper was originally intended to be a review of three groups only, *Cuna*, *Condylocardia* and *Cyamiomactra*, but it has been extended to cover most of the minute bivalves living on the coast of New South Wales. In the course of the investigation so many minute forms came under observation, many of rather obscure classification, that the opportunity was taken to study and draw them, and thus the scope of the paper was gradually extended. The term minute is not an arbitrary one, but is here taken to refer to shells less than about 3 mm. in size. An exception is *Cunanax pisum* Hedley, which is 6 mm. in height, but the other members of this family are all minute, so this species could hardly be excluded. The only really small shells not dealt with are certain deep water forms such as *Cyrilla*, *Bathyarca*, *Cratis*, *Notomytilus* and *Pronucula*. These were omitted either because of insufficient material, or because there was nothing new to add to the excellent work done by the late Charles Hedley.

Practically all the material here dealt with has been collected by my son John and myself in the last twenty years, and to my collecting partner must go most of the credit for picking out the rarities and novelties from shell sand and dredgings. To Mr. Tom Iredale my thanks are also due, for throughout he has given me the benefit of his great experience and much advice concerning the classification.

All types and specimens illustrated have been presented to the Australian Museum.

The Cuna Group of Genera.

Genus **Cuna** Hedley, 1902.

Genotype, *Cuna concentrica* Hedley.

The main characters taken from Hedley's description are :—"A genus of the Crassatellitidae. Shell very small, equilateral or slightly rostrate, higher than long with lunule and impressed dorsal area, beaks erect, prodissoconch marked, valves sometimes clasping. Sculpture concentric. Inner ventral margin usually denticulate. Hinge plate broad and flat; in the left valve two well developed cardinals; in the right a rudimentary cardinal and a massive, projecting, flat-topped and triangular cardinal. Laterals produced, sometimes transversely striated, a posterior and anterior in each valve. Ligament partly internal, protruding in a notch below the beaks."

Hedley included the two species *delta* and *atkinsoni* in *Cuna*, and later described two new species, *C. particula* and *C. pisum*. Iredale (1930) pointed out that these were a very heterogeneous group, and proposed the new genera *Volupicuna*, *Saltocuna* and *Cunanax*, but beyond indicating genotypes did not append generic descriptions. Cotton in his excellent work on the Pelecypods of South Australia (1938) added two more genera *Hamacuna* and *Propecuna*. Even among the South Australian shells still listed under *Cuna* there is such diversity that, had they been larger, further generic differentiation would surely have been undertaken. This has now been done with the New South Wales species, and to keep the relationship clear I have followed Iredale and Cotton in retaining the word "*cuna*" in some part of the new generic names.

The systematic position of *Cuna* and other small genera is still rather obscure. Hedley placed *Cuna* with the Crassatellitidae, a quite reasonable classification for, in hinge and other characters, it conforms broadly with this family. In view of the minute

size, however, of all the species here discussed, it would seem there is some other factor which binds them together. With the rather similar group of *Condylocardia* the view has been advanced that it is a degenerate branch of the Carditellidae in which growth has been arrested shortly after the prodissoconch stage. If this view be correct, it is possible that *Cuna* and its allies bear the same relationship to such large shells as *Crassatellites*, as *Condylocardia* does to *Cardita*. There are so many elements in the southern Australian molluscan fauna which have survived from the past, that in the problem of phylogenetic relationship fossil evidence is likely to be of more importance than comparison with other contemporary geographical provinces. With the larger forms such as the Volutes, much work has already been done, particularly in New Zealand, and even the smaller gasteropods, notably the Pyramidellidae and the Rissoidae have not been neglected. In Australia the only available Tertiary marine rocks are the mainly Miocene beds of Victoria and South Australia, and though from these many species of mollusca have been described, knowledge of the smaller forms is still very fragmentary. There is a wonderful field here, a field which needs long and specialized study, and one cannot do more at present than point out its possibilities.

Cuna concentrica Hedley.
(Figures 1, 1*a*.)

Hedley 149.

This is a deep water species, the type locality 63—75 fathoms off Port Kembla. The specimen figured is one collected by the late Charles Hedley from 111 fathoms off Cape Byron: its dimensions are, height 1·8 mm., length, 1·6 mm. The colour is white, the concentric sculpture strong, and it is a robust little shell.

Cuna littoralis, sp. nov.
(Figures 2, 2*a*, 2*b*.)

Shell very small, trigonal, flat, nearly an equilateral triangle, with the lower margin curved, height equal to length, white and translucent. Anterior margin sharp and slightly concave, lunule elongate, posterior margin straight, ventral margin curved and dentate anteriorly. Umbos erect, sharp, with a distinct but very small prodissoconch. Sculpture concentric, strong, about 30 rounded ribs, equal in width to the spaces between. Muscular scars visible but faintly impressed, pallial line entire. Hinge of the right valve with a strong, massive triangular, subumbonal, cardinal tooth, left valve with two diverging cardinals, lateral teeth elongated and not prominent. Height 2·2 mm., length, 2·2 mm.

Localities.—Common on Ocean Beach, Manly (type); also Cronulla and other outer beaches; 6—9 fathoms, Sow and Pigs Reef; 15—25 fathoms, Twofold Bay.

Remarks.—This species is closely allied to *C. concentrica*, and for long we had it labelled with that species. Comparison with the type, however, shows it to be a rather thinner shell, more triangular in shape, and relatively broader. Some slight variation in shape is shown in the dredged specimens which are smaller, with a straighter anterior margin, but otherwise no difference could be detected. Under the microscope in some lights what appear to be radial rays may be detected, but these appear to be differences in translucency rather than incipient radial sculpture.

Genus **Ovacuna**, gen. nov.

Genotype, *Cuna atkinsoni*, Ten.-Woods.

Related to *Cuna*, but oval in shape, slightly inflated, with large erect umbos, robust in habit, the concentric sculpture confined to faint growth lines, inner ventral margin strongly denticulate, adductor scars and entire pallial line strongly impressed. Right valve with a strong, triangular, bifurcate, subumbonal cardinal, left valve with two diverging cardinals, the anterior larger and bifurcate. Laterals elongated and not conspicuous. Prodissoconch not prominent.

The South Australian species *Cuna solida* Cotton should probably also come here.

Ovacuna atkinsoni (Ten.-Woods).

(Figures 3, 3*a*, 3*b*.)

Hedley 148.

In appearance this species is superficially not unlike some small mussels and is generally yellowish or yellow-brown in colour. It is very easily distinguished by its shape from all other cognate local species. The specimen figured came from 15 fathoms between the Heads, Port Jackson, and is 2·2 mm. in height, with a length of 1·7 mm. It is not a common species.

Genus **Volupicuna** Iredale, 1938.

Genotype, *Cuna delta* Tate and May.

Related to *Cuna*, but with distinct radial sculpture, triangular, solid, deep, anterior margin truncate, excavate with a large well-pronounced lunule. Inner ventral margin denticulate. Hinge plate large, left valve with a larger bifurcate cardinal and a smaller one anteriorly, right valve with two diverging, bifurcate cardinals. Pallial line and adductors faintly impressed.

Volupicuna novacambrica, sp. nov.

(Figures 4, 4*a*.)

Hedley 150 (*Cuna delta*).

Shell very small, triangular, rather deep, equilateral, anterior margin straight, posterior margin slightly convex, ventral margin rounded and denticulate within. Umbos erect with a distinct prodissoconch set in a circular, saucer-like depression. Colour white or yellowish. Adductor scars very faintly impressed, hardly visible. Anterior margin truncate with large, prominent lunule. Sculpture not prominent, consisting of faint, concentric growth lines crossed by 8 or 9 imperfectly defined radial ribs. Left valve with a triangular, bifurcate, median placed cardinal, and a small anterior cardinal, right valve with two, diverging, bifurcate cardinals, hinge plate large. Height 2·1 mm., length 1·7 mm.

Localities.—6—9 fathoms, Sow and Pigs Reef, Port Jackson (type); 30—35 fathoms off Crookhaven; also occasionally on ocean beaches.

Remarks.—The true *V. delta* is the Tasmanian species, and the New South Wales form has always been previously identified with it. Comparison, however, shows that the local shell is quite different, and among other characters is a much narrower shell.

Genus **Saltocuna** Iredale, 1936.

Genotype, *Cuna particula* Hedley.

Related to *Cuna* but oblique and very inequilateral, the hinge of the same general type, but the hinge plate long and narrower. Inner ventral margin denticulate. Sculpture concentric. Prodissoconch distinct and comparatively large.

Saltocuna particula (Hedley).

(Figures 5, 5*a*.)

Hedley 151.

The type locality is 63—75 fathoms off Port Kembla. We have a number of specimens from 40–50 fathoms off Port Stephens, that figured being 2·2 mm. long and 2·2 mm. high. The oblique form, truncate anterior margin and expanded posterior margin distinguish this from all other species related to *Cuna*.

Genus **Hamacuna** Cotton, 1931.

Genotype, *Cuna hamata* Hedley and May.

Cotton gives as the essential characters of his genus:— "The unique, hooked, ventrally directed umbos and massive compressed hinge plate." Sculpture of genotype concentric, but if the species here added from New South Wales is co-generic it may also be radial. Cardinal teeth heavy and massive.

Hamacuna radiata, sp. nov.

(Figures 6, 6*a*.)

Shell relatively large, massive, elongate-ovate, higher than long, sub-equilateral, umbos large and elongated, twisted posteriorly and slightly overhanging. Prodissoconch small and circular, barely distinguishable. Hinge plate large and massive, left valve with a large, massive, triangular cardinal tooth, right valve with two strong cardinals converging below the umbo, between them a small deep chondrophore, laterals strong in both valves, lunule very slight. Adductor muscle scars and entire pallial line moderately impressed. Colour white. Inner ventral margin denticulate. Sculpture consisting of about 16 strong, rounded, radial ribs, fading on the umbos, crossed by fine but well defined concentric growth lines. Height, 4 mm., length, 3·5 mm.

Locality.—14 fathoms off Long Reef, one complete specimen and 5 single valves.

Remarks.—This resembles in general form the genotype *H. humata*, a Tasmanian deep-water shell which is also recorded from Victoria and South Australia. The umbos are not, however, quite so twisted, and it is of course easily distinguished by its strong radial sculpture.

Genus **Propecuna** Cotton, 1931.

Genotype, *Cuna obliquissima* Tate.

Cotton gives the following essential characters for his genus:— "The peculiar concentric grooves cutting obliquely across the accremental striae, and the presence of marked posterior radial grooves and dorso-ventral angulations serve to distinguish this genus from *Cuna*."

No species of this genus has yet been recognized from New South Wales.

Genus **Mesocuna**, gen. nov.

Genotype, *Mesocuna saza* Laseron.

Shell small, massive, ovate, higher than long, equilateral, umbos prominent and erect. Hinge plate massive, the left valve with a massive, triangular cardinal, the right valve with two, massive, diverging cardinal teeth, laterals strong and elongate, chondrophore subumbonal and deep, pallial line entire and adductor scars slightly impressed. Sculpture radial, crossed by growth lines.

This genus generally resembles *Hamacuna*, but the umbos are erect, and the shell is nearly equilateral.

Mesocuna saza, sp. nov.

(Figures 7, 7*a*.)

Shell small, massive, elongate-ovate, equilateral, higher than long, umbos prominent, erect, prodissoconch small and round. Posterior margin straight, anterior margin very slightly convex, ventral margin rounded. Hinge plate massive with a strong triangular cardinal in the left valve, and two equally strong, diverging cardinals in the right valve, laterals strong and elongated, chondrophore small, deep and subumbonal. Colour white. Sculpture consisting of about 20 strong, regular, rounded, radial ribs, crenulated by numerous, fine, well-defined, concentric growth lines. Inner ventral margin of valves denticulate. Height, 2·5 mm., length, 2 mm.

Localities.—14 fathoms off Long Reef (type); 18 fathoms off North Head; dredged in Port Stephens; Ocean Beach, Manly.

Remarks.—The strong radial sculpture distinguishes this from all other *Cuna*-like shells, except *Hamacuna radiata*, than which it is much smaller, and it also lacks the twisted umbos.

Genus **Cunanax** Iredale, 1936.

Genotype, *Cuna pisum* Hedley.

Hedley's species was described from a single specimen with joined valves, and the hinge was evidently not visible and was left undescribed. Iredale, when he proposed *Cunanax*, gave no further particulars, beyond remarking that it was a much larger, crasser shell (than *Cuna*), with a hinge of a different type. To supply the omission the ollowing characters may be noted:—

Shell comparatively large, thick and massive, inequilateral, umbos tumid and turned anteriorly, prodissoconch not distinguishable, hinge plate broad and massive, the left valve with two massive, triangular, diverging, bifurcate cardinals, the right valve with two strong, laterally placed, diverging cardinals, with two thinner teeth between. Pallial line entire, adductor scars moderately impressed. Sculpture primarily radial. Inner ventral margin strongly denticulate.

The hinge at once distinguishes this from all other members of what might be called the *Cuna* group of genera, and it would seem to have entirely different relationship. It is suggested that this will be found with fossil rather than other living bivalves.

Cunanax pisum (Hedley).

(Figures, 8, 8*a*, 8*b*.)

Hedley 152.

The description given above should serve for the future recognition of this shell. The figured specimen was dredged in 15 fathoms off North Head, Port Jackson, where it was abundant, its height 6 mm., length 6·5 mm. It was also abundant in dredgings from 14 fathoms off Long Reef.

Family Condylocardiidae.

Cotton gives as the characters of this family:— "Shells minute, related to the Carditidae, but which retain in the adult state the immaturity of hinge characters which characterises the nepionic shell of *Cardita*, and moreover, have the resilium sunken and centrally located between the valves. The prodissoconch is of the usual size, but appears very prominent on account of the relatively small additions made to it in growth." He includes in the family two genera, *Carditella* E. A. Smith, and *Condylocardia*. As *Carditella* is small but not minute, and has among other characters an external ligament, it might well be left in the Carditidae where it was orginally placed, and it is not dealt with here. The Australian species which have been included in *Condylocardia*, a New Zealand genus, form a complex group, between some of which there appears little relationship. Iredale (1936) recognized this and proposed two new genera *Condylocuna* and *Radiocondyla*, but beyond designating genotypes, he gave no descriptions. Unfortunately most of the species are so minute that it is very difficult to determine their hinges even under the microscope. Slight changes in lighting and viewpoint often give an entirely different impression. Fortunately the different species are easy to distinguish and they fall into groups which seem natural and which may be generically separated.

Figures 1—21.

1, 1*a*. *Cuna concentrica* Hedley. 2, 2*a*, 2*b*. *Cuna littoralis* Laseron. 3, 3*a*, 3*b*. *Ovacuna atkinsoni* (Ten.-Woods). 4, 4*a* *Volupicuna novacambrica* Laseron. 5, 5*a*. *Saltocuna particula* Hedley. 6, 6*a*. *Hamacuna radiata* Laseron. 7, 7*a*. *Mesocuna saza* Laseron. 8, 8*a*, 8*b*. *Cunanax pisum* Hedley. 9. *Radiocondyla rotunda* Laseron. 10, 10*a*. *Condylocardia kunopia* Laseron. 11, 11*a*. *Condylocardia rotunda* Laseron. 12, 12*a*. *Condylocardia* sp. 13, 13*a*. *Condylocuna cambrica* Iredale. 14, 14*a*. *Condylocuna minuta* Laseron. 15, 15*a*. *Benthiocardiella vitrea* Laseron. 16. *Condylocuna projecta* Hedley. 17, 17*a* *Condylocuna ovata* Hedley. 18, 18*a* *Condylocuna moringa* Laseron. 19, 19*a*. *Radiocondyla jacksonensis* Laseron. 20, 20*a*, 20*b*. *Particondyla cuneata* Laseron. 21, 21*a*, 21*b*. *Neolepton novacambrica* Hedley.

Genus **Condylocardia** Bernard, 1896.

Genotype, *C. sanctipauli* Bernard.

The Australian species which most approaches the genotype is that listed in May's Tasmanian list as *C. crassicosta* Bernard, and without expressing an opinion as to the correctness of May's identification, this may be taken as co-generic with several New South Wales species at present undescribed. The characters which they have in common are their minute size, all in the vicinity of 1 mm., their pectinate shape and strong radial sculpture. All are white and subtranslucent. The prodissoconch is comparatively very large, consisting of a tumid dome rising from a saucer-like depression. The hinge plate is wide, its dorsal margin bordering the rim of the prodissoconch, and one or two obscure cardinals are present with an anterior lateral. The form of the shell varies from inequilateral to very nearly equilateral.

Condylocardia kunopia, sp. nov.

(Figures 10, 10*a*.)

Shell minute, broadly ovate, inequilateral, anterior margin long and straight, posterior margin shorter and straight, ventral margin rounded, prodissoconch comparatively very large, consisting of a saucerlike depression with an outer rim, and within a broad, rounded protuberance. Colour white and translucent. Hinge plate wide, bordered by the rim of the prodissoconch, right valve with an obscure cardinal and an anterior lateral. Sculpture consisting of 11 or 12 prominent, rounded, radial ribs, separated by rather wide shallow channels. Ventral margin slightly crenulate. Height, 1·1 mm., length, 1 mm.

Locality.—Shell sand, Narrabeen. (Several specimens.)

Remarks.—This resembles *C. crassicosta* as figured from Tasmania, but it is relatively longer in proportion to its height and has a larger prodissoconch.

Condylocardia rotunda, sp. nov.

(Figures 11, 11*a*.)

Shell minute, white, subtranslucent, equilateral, nearly circular in shape, with anterior and posterior margins slightly flattened, slightly longer than high. Prodissoconch large, saucer-shaped with an external ring, almost filled by a broad, dome-shaped protuberance. Hinge plate broad and narrow with obscure laterally placed cardinals, anterior lateral well defined, long and narrow. Sculpture about 14 prominent, rounded, well-defined, regular, radial ribs, separated by rounded furrows, and slightly tuberculated by faint concentric sculpture. Dorsal margin crenulated.

Adductor muscles and pallial line not indented. Height 0·9 mm., length 1 mm.

Locality.—Narrabeen in shell sand, a number of specimens.

Remarks.—The rotund shape and symmetry at once distinguish this from other species of this group.

Condylocardia sp.

(Figures 12, 12*a*.)

A single, rather worn specimen of an undescribed species was sorted from sand from 15—25 fathoms, Twofold Bay. It is felt that the material is insufficient at this stage to justify a new specific name, so it is figured for future reference. The shell is white and minute, height 1 mm., length 1·1 mm. and in form it approaches closely to *C. kunopia*, but differs chiefly in the prodisso nch. This is saucer-shaped, rising above the summit of the shell, is very flat on top, and the enclosed protuberance is small and high.

Genus **Condylocuna** Iredale, 1936.

Genotype, *Condylocardia projecta* Hedley.

Beyond naming the genotype, Iredale gave no description beyond saying that it had concentric sculpture and the hinge formation was different. To this may be added that the shell is generally strongly inequilateral, though the different species gradate to nearly symmetrical forms, as in *C. trifoliata*. The hinge features are rather obscure and difficult to define, but the hinge plate is generally broad and abuts directly on the straight line of the prodissoconch. One or two cardinals are present in each valve but they are narrow and ill-defined. Laterals are also present. The prodissoconch is circular, large and distinctive, consisting of a number of concentric rings, one within the other. Of species outside New South Wales, Cotton's species *isosceles* comes within this group.

Condylocuna projecta Hedley.

(Figure 16.)

Hedley 165.

This species may readily be recognized by the peculiar shape; it is very inequilateral, with the umbos posteriorly placed, the dorsal margin being contracted just below the large prodissoconch, which consists of two or three large concentric rings with a medially cleft central protuberance. The hinges of our specimens do not show the characters well, but Hedley says:— "in the right valve a feeble anterior and posterior cardinal; in the left a single, massive posterior cardinal; in each valve an anterior lateral." The sculpture is strongly concentric. The type figured by Hedley was dredged in Watson's Bay and it also occurs on the continental shelf. Our specimens come from shell sand, Narrabeen, that figured being 1·1 mm. in height and 1.4 mm. long.

Condylocuna ovata Hedley.

(Figures 17, 17*a*.)

Hedley 162.

The type came from Manly Beach. We have only found one specimen of this species, a right valve from shell sand at Angowrie on the North Coast. This is evidently not mature and is smaller than the type, being 0·8 mm. in height with a length of 1·3 mm. The species can be recognized by its obliquely ovate shape, its very fine concentric sculpture, often nearly smooth, and its large, faintly concentric prodissoconch. Hedley figures but does not describe the hinge. That in our specimen appears to have two laterally placed cardinals, the posterior bifurcate, the anterior bow-shaped, with an anterior and posterior lateral, but even under the microscope the details are obscure.

Condylocuna moringa, sp. nov.

(Figures 18, 18*a*.)

Shell large for the genus, solid, white, obliquely ovate, inequilateral but not markedly so, umbos posteriorly placed. Prodissoconch extremely large, circular, consisting of numerous concentric rings within each other with a small nucleus. Hinge plate long and narrow, the cardinals laterally placed, small and obscure, anterior lateral well defined, adductor scars not impressed. Ventral margin of valves denticulate within. Sculpture concentric and strong, the later ridges posteriorly overlapping the earlier ones. Height 2 mm., length 2·5 mm.

Locality.—Dredged off North Head, Port Jackson, in 15 fathoms.

Remarks.—Closely related to *C. ovata*, from which it differs by its more solid shell, by being less inequilateral, and by its still larger and peculiar prodissoconch. The specific name is derived from Moring the aboriginal name for Bottle and Glass Rocks, just within the harbour. With *C. projecta* and *C. ovata* it forms a small natural group, distinguished from the following three species by being longer than high.

Condylocuna cambrica Iredale.

(Figures 13, 13*a*.)

Rec. Aust. Museum, 1936, XIX, p. 272.

Hedley 166 (*Cuna trifoliata*).

Hedley's type of *trifoliata* came from Mast Head Reef, North Queensland, and Iredale separated the New South Wales form as being " broader, less strongly sculptured, with a protoconch proportionately larger and less notably trifoliate." The type came from Chinaman's Beach, Middle Harbour, Port Jackson. We have a good series dredged from 6—9 fathoms, Sow and Pigs Reef within the harbour, that figured having a height of 1·1 mm. and a width of 0·7 mm. The concentric sculpture varies somewhat, sometimes almost smooth, sometimes moderately strong. The prodissoconch is distinctly trifoliate as in the Queensland shell and the proportions are much the same, but the New South Wales shell is nearer equilateral and this justifies Iredale's separation. The hinge, as with others of the group, is rather obscure, but the hinge plate is comparatively deep, with a larger posterior and a small anterior cardinal in the right valve, and an anterior lateral. The adductor scars are not impressed, but are visible externally through the translucent shell.

Condylocuna minuta, sp. nov.

(Figures 14, 14*a*.)

Shell extremely minute, white and translucent, obliquely ovate, higher than long, produced anteriorly, umbos posteriorly placed, anterior and posterior margins slightly convex. Prodissoconch relatively small but prominent, trifoliate. Hinge plate moderately deep, the cardinals obscure and ill-defined. Sculpture fine, but strongly and regularly concentric. Inner ventral margins slightly denticulate. Height 0·9 mm., length 0·8 mm.

Locality.—Abundant in shell sand, Narrabeen.

Remarks.—This is nearly the smallest of the New South Wales species. It is closely related to *C. cambrica*, but is much more oblique and has a much smaller prodissoconch.

Genus **Benthiocardiella** Powell, 1930.

Genotype, *B. pusilla* Powell.

A minute shell from Narrabeen seems to fit very well with the New Zealand genus *Benthiocardiella*. Powell based his genus on the hinge, stating that the right valve had three cardinals, an elongated anterior and two posterior, and the left valve two cardinals, one anterior and one posterior. In these minute shells it is difficult even under the microscope to determine the exact number and disposition of the teeth, and in the New South Wales species they are rather obscure. More easy recognition points are the smooth, glassy shell, nearly symmetrical, and the huge prodissoconch. It is probable that the South Australian species *Condylocardia isosceles* Cotton should also be included in *Benthiocardiella*.

Benthiocardiella vitrea, sp. nov.

(Figures 15, 15*a*.)

Shell extremely minute, white and glassy and transparent, vertically ovate, higher than long, very nearly equilateral but slightly produced anteriorly, anterior and posterior margins slightly convex. Prodissoconch large, of four concentric rings with a dome-shaped central nucleus. Hinge plate large, the right valve with two or three obscure cardinals, laterals not distinct. Sculpture faint concentric growth lines, otherwise smooth and shining. Height 0·8 mm., length 0·7 mm.

Locality.—Shell sand, Narrabeen.

Remarks.—This is even smaller than *Condylocuna minuta*. It is very close to *C. isosceles* Cotton, a South Australian species, but *C. isosceles* is practically equilateral and has a multifoliate prodissoconch rising to a peak.

Genus **Radiocondyla** Iredale, 1936.

Genotype, *Radiocondyla arezela* Iredale.

Iredale took as his genotype the Tasmanian shell which May had identified as *Condylocardia porrecta* Hedley. Iredale gives no generic characters, and in the absence of specimens of the genotype it is difficult to supply the omission. Iredale tentatively included *C. pectinata* in *Radiocondyla*, and we have this and two new species from New South Wales which may also be tentatively included. From May's figure and from these we may summarize some generic characters. Shell generally larger than the true *Condylocardia*, heavier and more massive, more inequilateral, with a smaller prodissoconch, the sculpture strongly radial, the ribs crossed by fine concentric ridges.

The hinge characters vary in the three species here listed, but no definite characters could be selected on which to justify immediate generic separation. Further study may justify this at a later date.

Hedley included *Condylocardia porrecta* on the New South Wales list (No. 164), but I can find no direct reference to its occurrence in this State. The type comes from Mast Head Island in North Queensland and differs from any of the cognate species we have examined, and in the absence of any clear record it should be omitted from the New South Wales list.

Radiocondyla jacksonensis, sp. nov.

(Figures 19, 19*a*.)

Hedley 163. (*C. pectinata* Tate and May.)

Shell very small, yellow-brown, vertically ovate, nearly equilateral, higher than long, anterior margin straight and slightly aurate, posterior margin straight, heavy and solid. Prodissoconch very small, horseshoe-shaped, vertically placed on the extreme tip of the umbo. Sculpture strongly radial, consisting of about 15 rounded ribs about equal in width to the grooves between and plicated by the fine, concentric growth lines. Inner ventral margin denticulate. Hinge plate long and rather narrow, one or two obscure cardinals, posterior lateral well marked. Height 1·5 mm., length 1.4 mm.

Locality.—Abundant in sand, 6—9 fathoms, Sow and Pigs Reef, Port Jackson.

Remarks.—*R. pectinata* is a South Australian species and has also been recorded from Tasmania. The New South Wales shell recorded as this species is quite distinct, being more equilateral, with straight anterior and posterior margins. The suggestion of a slight wing anteriorly is also distinctive.

Radiocondyla ampla, sp. nov.

(Figure 22.)

Shell comparatively large, solid and massive, slightly inequilateral, broadly ovate, as high as long, colour white. Adductor scars slightly impressed and visible. Prodissoconch comparatively large, separated from the main shell by a ridge, the large central dome nearly filling the usual saucer-shaped depression. Right valve with two diverging cardinals on a large hinge plate, ligament internal in a small subumbonal pit. Sculpture consisting of about 15 broad, rounded radial ribs, separated by narrow, shallow furrows, and crossed by fine concentric striae. Ventral margin crenulate both externally and internally. Height 2·9 mm., length 2·8 mm.

Locality.—14 fathoms off Long Reef, one left valve and a pair of united valves.

Remarks.—This species approaches very close to *Condylocardia subradiata* Tate from South Australia, but is not so inequilateral and more rounded.

Radiocondyla rotunda, sp. nov.

(Figure 9.)

Shell of medium size, solid, sub-circular, nearly equilateral, colour white. Prodissoconch large and prominent, consisting of several concentric rings with a small nucleus. Adductor muscle scars not impressed. Hinge plate short and wide, the

left valve with two short cardinals and a long narrow posterior laterial. Sculpture consisting of about 18 rounded radial ribs, about equal in width to the furrows, and crossed by fine concentric striae. Inner ventral margin strongly crenulate. Height 2·2 mm., length 2·4 mm.

Locality.—30—35 fathoms off Crookhaven.

Remarks.—The nearly equilateral shell and nearly circular outline separate this from all cognate species and should make its future recognition easy.

Genus **Particondyla**, gen. nov.

Genotype, *Particondyla cuneata* Laseron.

Shell large for the group, inequilateral, higher than long. Prodissoconch small, saucer-shaped with a central protuberance, ligament internal, hinge plate deep and narrow, left valve with a large, triangular cardinal, fitting between two thin diverging cardinals in the right valve. Sculpture radial.

The large, massive, triangular tooth in the left valve separates this from other members of the family, and suggests some relationship with *Cuna* and its allies, but the prodissoconch is typically that of the group *Condylocardia*, and it is retained here, though its exact relationship is yet uncertain.

Particondyla cuneata, sp. nov.

(Figures 20, 20*a*, 20*b*.)

Shell comparatively large, massive, inequilateral, wedge-shaped, higher than long anterior margin nearly straight, posterior margin slightly convex, ventral margin evenly curved. Colour very pale yellow. Prodissoconch small, a central dome set within a saucer-shaped depression with a slight rim. Adductor muscle scars not impressed. Hinge plate triangular, narrow and deep, left valve with a massive triangular cardinal fitting between two narrow diverging cardinals in the right valve, laterals not prominent, lunule narrow. Sculpture consisting of about 20, prominent, rounded, radial ribs, separated by narrow furrows, crossed by fine, narrow concentric ridges, inner ventral margin denticulate. Height, 2·8 mm., length 2·2 mm.

Locality.—14 fathoms, off Long Reef, 4 specimens.

Remarks.—There is no other species with which this can be confused, its oblique wedge shape and hinge at once distinguishing it from all others with radial sculpture.

Warrana, gen. nov.

Genotype, *Warrana dielasma* Laseron.

The generic name *Warrana* is here proposed for three undescribed species of uncertain classification, which while presenting certain features in common may yet be found to have little relationship. All are minute, almost equilateral, much higher than long, with the appearance somewhat of small brachiopods of the *Terebratula* type, and have concentric sculpture. All have small distinct prodissoconchs separated by grooves, and inclined to be rectangular. The sculpture is concentric. Hinge characters are rather obscure, the hinge plate varying in size, with one or two indistinct cardinals. In the genotype the ligament is internal in a small subumbonal pit. The name *Warrana* is derived from Warrane the aboriginal name for Sydney.

Warrana dielasma, sp. nov.

(Figure 23).

Shell minute, bright yellow-brown, solid but subtranslucent, vertically ovate, higher than long, very nearly equilateral and symmetrical, the posterior (?) margin slightly more convex than the anterior (?). Prodissoconch distinct, separated by a groove and nearly rectangular and flat. Adductor scars impressed and visible, pallial line entire. Hinge characters rather obscure, the hinge plate well developed, with one

or two obscure cardinals. Sculpture consisting of 8 or 9 more or less defined, narrow concentric folds, the spaces between smooth and vitreous. Height 1 mm., length 0·7 mm.

Locality.—A number of specimens in shell sand, Narrabeen.

Remarks.—This is totally unlike any other bivalve described from Australian waters, and its resemblance in shape to the fossil brachiopod *Dielasma* and others of that type should make future recognition very easy.

Warrana vitrea, sp. nov.

(Figures 24, 24*a*.)

Shell minute, white, vitreous and shining, irregularly ovate, higher than long, acute dorsally, broadened ventrally, nearly equilateral, anterior margin nearly straight, posterior margin convex, ventral margin irregularly curved, slightly prolonged posteriorly. Prodissoconch prominent, a saucer-shaped depression nearly filled by a high dome-shaped nucleus. Hinge plate large and triangular, with one or two obscure cardinals, laterals not distinct. Adductors scars not impressed. Sculpture practically none, confined to a few irregular concentric growth lines, surface smooth and shiny. Height 1·2 mm., length 1 mm.

Locality.—Shell sand, Narrabeen; a number of specimens both single and united valves.

Remarks.—Tentatively included generically with the former species, its classification is not yet certain. It is a very distinctive species, not readily confused with any other.

Warrana eccentrica, sp. nov.

(Figures 25, 25*a*.)

Shell minute, white, solid, opaque, irregularly subquadrate, higher than long, nearly equilateral, anterior margin shouldered and straight, posterior margin rounded, the whole shell broadening slightly to the ventral margin which is rounded. Prodissoconch small but prominent, with a large, high, rather angular nuclear dome, nearly filling a saucer-shaped depression. Adductor muscle scars not impressed. Hinge plate rather long and narrow, the left valve with a large single, posteriorly sloping cardinal and a small subumbonal cardinal. Interior ventral margin strongly denticulate. Sculpture strongly concentric, consisting of about 12 regular, rounded folds about equal in width to the furrows between. Height 1·5 mm., length 1·2 mm.

Locality.—A single left valve from 20—25 fathoms, Shoalhaven Bight.

Remarks.—Though described from a single specimen, the form and characters of this peculiar little species are so distinctive that there should be no difficulty in its future recognition. Like so many of the small bivalves its classification is anomalous, but its general form corresponds well enough with the two previous species to warrant its tentative inclusion in the same genus. There is no other species with which it can readily be confused.

Family Cyamiidae.

Genus **Cyamiomactra** Bernard, 1897.

The systematic position of *Cyamiomactra* has been dealt with by Cotton, who includes it in the family Cyamiidae, a family confined to Antarctica and Australasia. A prominent feature of all the Australian species, which Cotton omitted to mention, is the relatively large prodissoconch, which is round and flattened, and often with the edges protruding beyond the top of the adult shell. Species which may be fairly included in *Cyamiomactra* n New South Wales include more than listed in Hedley's check list, and amongst these there is considerable difference in the hinge characters, but whether the difference is merely specific, or whether it warrants generic separation is entirely at the moment a matter of opinion. My own opinion is that it does not, and I am content to let the matter rest there.

Cyamiomactra mactroides Tate and May.

(Figures 27, 27*a*, 27*b*.)

Hedley 209.

If all the identifications are correct this species has a very wide range—Tasmania, South Australia, Victoria and Queensland. In New South Wales it is common in many localities, particularly the outer beaches. The specimen figured is from 6—9 fathoms, Sow and Pigs Reef, its height 1·8 mm. and length 2·2 mm. Local specimens agree very well with and cannot be separated, superficially at least, from those figured from both Tasmania and South Australia. Good recognition points are the shape and pink coloration.

Cyamiomactra communis Hedley.

(Figures 28, 28*a*, 28*b*.)

Hedley 208.

The type came from Manly Beach, and the specimen figured is from the same locality, its dimensions, height 1·2 mm., and length 2 mm. It has since been recorded from Tasmania and South Australia. It can be readily distinguished from *C. mactroides* by its smaller size, white coloration and more regular oval shape.

Cyamiomactra symmetrica, sp. nov.

(Figures 29, 29*a* &, 29*b*.)

Shell minute, pinkish-yellow, shining, broadly ovate, longer than high, nearly equilateral, umbos centrally situated, upright, anterior and posterior margins slightly convex and equal, ventral margin semi-circular and even. Prodissoconch small but distinct, like a small, rounded circular cap. Adductor muscle scars and pallial line not impressed. Left valve with a strong, bifid cardinal tooth, with a shorter posterior limb, right valve with two, diverging, bow-shaped teeth, and between them a minute cardinal. Ligament internal, subumbonal. Sculpture to the eye smooth and shining, but beneath the microscope very fine, concentric growth lines. Internal ventral margin smooth. Height, 1·9 mm., length 2·3 mm.

Locality.—30—35 fathoms off Sydney, a number of specimens.

Remarks.—This is not readily confused with other species of *Cyamiomactra*, from which it may be at once distinguished by its symmetrical shape. There is another species, however, described later in this paper as *Micropolia typica* (Fig. 33), which is so close superficially that it is difficult to separate. This, however, has a quite different hinge, and lacks the distinct prodissoconch.

Cyamiomactra distorta, sp. nov.

(Figures 30, 30*a*, 30*b*.)

Shell small, yellowish-brown, with red-brown umbos, moderately solid, very slightly translucent. Contour rather irregular, umbos nearly central, anterior margin narrowed and prolonged, posterior margin nearly truncate, ventral margin rounded. Umbos prominent and upright, with a small rounded prodissoconch. Adductor muscle scars very faintly impressed. No marked hinge plate, the left valve with a strong, inverted, bifid cardinal tooth, flanked by short, well-marked bow-shaped laterals, right valve with two deep, diverging, bow-shaped teeth, the anterior the more prominent and rather pointed. Sculpture to the eye smooth and shining, microscopically with fine, concentric growth lines, no trace of radial scupture, interior ventral margin smooth. Height 1·9 mm., length 2·5 mm.

Locality.—Shell sand, Port Stephens, a number of specimens.

Remarks.—It bears a general resemblance to *C. mactroides*, but can be readily separated by its irregular shape, smooth inner ventral margin and lack of radial sculpture, also by details of the hinge.

Cyamiomactra nitida Hedley.

(Figures 31, 31*a* (after Hedley).)

Hedley 207.

I have not yet seen this species, the type locality of which is 20 fathoms off Sussex Inlet, New South Wales. The species elsewhere described as *C. symmetrica* was at first labelled *C. nitida*, but a comparison of the figures at once shows the difference. Hedley gives the dimensions as height 2·2 mm., length 2·6 mm.

Cyamiomactra carina, sp. nov.

(Figures 26, 26*a*, 26*b*.)

Shell comparatively large, white to pinkish, glassy and translucent, oval, umbos prominent, about one-third from the anterior end, upright. A slight but definite keel runs obliquely to the posterior ventral margin. Prodissoconch comparatively large and distinct, rounded and rather flattened, with extended edges. Adductor muscle scars and pallial line very faintly impressed. Left valve with a strong, anterior, inverted V-shaped cardinal, and two posterior thin cardinals on a fairly wide hinge plate, right valve with three thin divergent cardinals, laterals not distinct. To the eye no sculpture is visible and the surface is smooth and shining, but under the microscope regular, fine, concentric growth lines are visible, also radiating translucent rays, which slightly indent the shell near the ventral margin. Interior ventral margin faintly crenulate. Height 2·3 mm., length 3 mm.

Localities.—Manly Beach (type); Cronulla and other outer beaches.

Remarks.—The regular oval shape, and the slight keel at once separate this from all other local species. Though placed tentatively in *Cyamiomactra* its exact systematic position is doubtful.

Genus **Calvitium**, gen. nov.

Genotype, *Calvitium glabra* Laseron.

Shell minute, thin, translucent, equivalve, inequilateral, closed, umbos anteriorly placed, tumid, erect. Prodissoconch large and dome-shaped. Ligament obscure and nearly obsolete, internal. Adductor scars large, faint, pallial line faint, apparently entire. Left valve with a small, rounded cardinal tooth, anteriorly placed, with a large fold of the hinge, hardly a tooth, behind, and two prominent laterals. Right valve without cardinal teeth, but two prominent laterals.

This is another of the small Australian bivalves for which it is difficult to find relationship with any of the larger and better known families. The obsolete ligament, form of the large prodissoconch, and general shell characters suggest that temporarily at least it may be placed with *Cyamiomactra* in the superfamily Cyamiaceae, but further revision of its systematic position will probably be necessary.

Calvitium glabra, sp. nov.

(Figures 32, 32*a*, 32*b*.)

Shell minute, white, translucent, elliptical, very inequilateral, rather inflated, margins rounded. Umbos at anterior end, large and tumid, erect, the prodissoconch very large and well defined, dome-shaped, lying within and encircled by a distinct narrow ridge. Surface of shell smooth, scupture confined to a few indefinite concentric growth lines. Adductor scars very faint and hardly discernible, but apparently large, with the faint pallial line entire. Dorsal margin formed by the edge of the prodissoconch. Left valve with a small, but prominent, almost spherical cardinal tooth anteriorly placed, and behind it a large rounded fold or tooth. The two laterals are elongated and well defined, the posterior the stronger. The right valve has no cardinal, but two well-defined laterals, while between them there is a small fold of the hinge projecting into the shell. Length 1·4 mm., height 1 mm.

Locality.—Quite common in shell sand, Gunnamatta Bay, Port Hacking.

Figures 22—44.

22. *Radiocondyla ampla* Laseron. 23. *Warrana dielasma* Laseron. 24, 24*a*. *Warrana vitrea* Laseron. 25. 25*a*. *Warrana eccentrica* Laseron. 26, 26*a*, 26*b*. *Cyamiomactra carina* Laseron. 27, 27*a*, 27*b*. *Cyamiomactra mactroides* Tate and May. 28, 28*a*, 28*b*. *Cyamiomactra communis* Hedley. 29, 29*a*, 29*b*. *Cyamiomactra symmetrica* Laseron. 30, 30*a*, 30*b*. *Cyamiomactra distorta* Laseron. 31, 31*a*. *Cyamiomactra nitida* Hedley (after Hedley). 32, 32*a*, 32*b*. *Calvitium glabra* Laseron. 33, 33*a*, 33*b*. *Micropolia typica* Laseron. 34, 34*a*, 34*b*. *Micropolia jacksonensis* Laseron. 35, 35*a*, 35*b*. *Micropolia depressa* Laseron. 36, 36*a*, 36*b*. *Micropolia ovalis* Laseron. 37, 37*a*, 37*b*. *Micropolia concentrica* Laseron. 38, 38*a*, 38*b*. *Micropolia profundis* Laseron. 39, 39*a*. *Cosa stephensensis* Laseron. 40, 40*a*. *Cosa auriculata* Laseron. 41, 41*a*. *Austrosarepta elliptica* Laseron. 42, 42*a*, 42*b*. *Spondervilia rubra* Laseron. 43, 43*a*. *Spondervilia simplex* Laseron. 44, 44*a*, 44*b*. *Spondervilia australis* Angas.

Genus **Micropolia**, gen. nov.

Genotype, *Micropolia typica* Laseron.

Shell minute, thin, translucent, subtrigonal, equivalve and nearly equilateral, smooth, sculpture confined to faint growth lines. Umbos erect, rather tumid. Ligament nearly obsolete, adductor muscles sub-equal, faintly impressed, generally visible externally, pallial line not visible. Left valve with a single, pointed trigonal cardinal tooth, sub-umbonal, anterior and posterior bow-shaped laterals. Right valve with no cardinal tooth but two bow-shaped laterals. Prodissoconch small and not prominent.

This genus is proposed for several species of minute shells which, though not uncommon, seem completely to have escaped notice. Superficially they resemble the deep-water shell named by Hedley *Neolepton novacambrica*, and at first it was thought that they were congeneric, but examination of the hinge showed that there is really little relationship. The hinge is quite distinctive. The single rather pointed cardinal tooth in the left valve, and the bow-shaped laterals in both valves at once define the genus. The systematic position of *Micropolia* is not certain. The obsolete ligament and shell characters suggest the Cyamiidae, and *Cyamiomactra* is possibly its nearest relation, but again it is probable that a new family should be introduced for its reception.

Micropolia typica, sp. nov.

(Figures 33, 33*a*, 33*b*.)

Shell minute, pinkish-white, thin, vitreous, translucent, sub-trigonal, moderately inflated, equivalve, almost equilateral, anterior and posterior margins slightly curved, ventral margin rounded. Umbos erect, tumid. Sculpture confined to faint growth lines. Adductor muscles faint, barely discernible within the shell, but visible externally. Hinge with a fairly strong pointed cardinal tooth in the left valve, flanked by bow-shaped laterals, the posterior the most prominent, right valve with no cardinal and only the two bow-shaped laterals. Length 2·3 mm., height 1·8 mm.

Locality.—30—35 fathoms off Crookhaven, fairly common.

Remarks.—This is very close to the next two species described, but it differs from both by its more tumid umbo.

Micropolia jacksonensis, sp. nov.

(Figures 34, 34*a*, 34*b*.)

Shell minute, yellowish with pink tinge, thin, translucent, nearly as high as long, subtrigonal, anterior and posterior margins nearly straight, ventral margin rounded, umbos erect, only moderately tumid, surface smooth with faint growth lines. Hinge almost as in *M. typica*, but with the anterior lateral in the left valve more elongated and not so bow-shaped. Length 2·2 mm., height 2·1 mm.

Locality.—6—9 fathoms, Sow and Pigs Reef, Port Jackson.

Remarks.—Almost identical with *M. typica*, but it differs chiefly in its less tumid umbo and greater height in proportion to its length. To *M. depressa* from the same locality it is even closer, and the greatest care must be taken in separating the species. This is mainly on account of their minute size. Even under a strong lens they appear to be identical, and at first all the specimens were grouped together. It was only under strong magnification that it was seen that two species were mixed, and then each individual specimen had to be compared under the microscope before they were finally sorted. The main difference is in the ratio of height to length, that in *M. jacksonensis* being 0·95 and in *M. depressa* 0·84.

Micropolia depressa, sp, nov.

(Figures 35, 35*a*, 35*b*.)

Shell minute, yellowish with a pink tinge, thin, glassy, translucent, general characters of hinge, umbos, etc., the same as in *M. jacksonensis*, but the umbos a little more pointed, and the shell longer in relation to its height. Length 2·5 mm., height 2·1 mm.

Locality.—6—9 fathoms, Sow and Pigs Reef, Port Jackson.

Micropolia ovalis, sp. nov.
(Figures 36, 36*a*, 36*b*.)

Shell, minute, thin, white, glassy and translucent, nearly a perfect oval in shape, nearly equilateral, rather longer than high, anterior, posterior and ventral margins rounded, umbos erect, tumid, with a distinct rounded prodissoconch. Surface smooth, the sculpture confined to faint concentric growth lines. Hinge as others in the group, with a small, subumbonal, pointed cardinal in the left valve, flanked by two laterals, the anterior the more prominent. Right valve with two laterals only, bow-shaped. Length 2·1 mm., height 1.6 mm.

Locality.—30—35 fathoms off Crookhaven.

Remarks.—These were easily picked out from *M. typica*, with which they were associated, by their oval shape and white colour, and by the presence of a distinct prodissoconch. The hinge is typically that of the other species, but the prodissoconch suggests relationship with *Cyamiomactra* and strengthens the possible link with the Cyamiaceae.

Micropolia concentrica, sp. nov.
(Figures 37, 37*a*, 37*b*.)

Shell minute, yellowish, thin, translucent, oval, rather longer than high, moderately inflated, not quite equilateral, the umbos not erect, tumid, pointing slightly anteriorly. Prodissoconch small and ill-defined. The surface is covered with very fine, regular, concentric sculpture, which under high magnification is slightly granulate. Hinge typically that of *Micropolia*, left valve with a small, central cardinal tooth and two bow-shaped laterals, right valve with two bow-shaped laterals only. Posterior margin slightly flattened, anterior and ventral margins rounded. Length 2·2 mm., height 1·7 mm.

Habitat.—Quite common living in beds of the common mussel between tide marks, North Harbour, Port Jackson.

Remarks.—This can easily be distinguished from the previous three species by the fine, concentric sculpture and less symmetrical shell. Were it not for the hinge it might well be placed in a separate genus.

Micropolia profundis, sp. nov.
(Figures 38, 38*a*, 38*b*.)

Shell minute, white, thin and translucent, oval, rather inequilateral, the umbos tumid and pointing slightly anteriorly, anterior, posterior and ventral margins rounded. Surface with very fine, regular concentric sculpture, under high magnification showing minute transverse striae. Hinge as in other members of the group with a small, pointed central cardinal tooth in the left valve flanked by two bow-shaped laterals. The two bow-shaped laterals in the right valve are strong and well defined. Prodissoconch comparatively large and well defined. Length 2·5 mm., height 1·9 mm.

Locality.—30 to 35 fathoms off Crookhaven, several single valves.

Remarks.—This is very close to *M. concentrica*, but there are small but definite differences which separate the two species. *M. profundis* is white, slightly larger and flatter, the posterior margin is more rounded, and the prodissoconch is larger and more distinct. The habitat is of course different, *M. concentrica* living between tide marks while *M. profundis* is an inhabitant of the deeper water on the continental shelf.

Notolepton novacambrica Hedley.
(Figures 21, 21*a*, 21*b*.)

Hedley 192.

When studying the species of *Micropolia* just described it was thought that one of these, particularly *M. jacksonensis*, might be Hedley's *Neolepton novacambrica* but, while the form was practically identical, the hinge could not be reconciled. Hedley's,

work was so consistent, and his drawings so accurate, that this could not be overlooked, and it was decided that *N. novacambrica* was not in the collection. Later two specimens, however, were sorted from material from 14 fathoms off Long Reef, and the difference in the hinge was at once apparent. A figure is here given for comparison, the dimensions being, length 2·4 mm., height 2·4 mm.

The generic name *Notolepton* was proposed by Finlay (1926), with *Kellia antipoda* Filhol as genotype, to replace *Neolepton* Monterosato (1875), a British group-name wrongly used. Finlay listed *novacambrica* in this genus.

Family Philobryidae.

Genus **Cosa** Findlay, 1926.

Genotype, *Cosa costata* (Bernard).

Findlay proposed *Cosa* to cover the New Zealand species of *Philobrya* which had costate sculpture, at the same time pointing out that the hinge differed from the true European *Philobrya*. He considered that the New South Wales species, *P. parallelogramma* is congeneric with the New Zealand *Cosa*. Iredale (1931) agreed with this and removed all the New South Wales species to *Cosa*, though Cotton (1938) retained *Philobrya* for the Adelaidean forms. It is doubtful if the true *Philobrya* occurs in Australia at all, and as the Adelaidean species are closely related to those from New South Wales, it would be better if they too were removed to *Cosa*. Iredale's genus *Denticosta*, which has a very different hinge, has so far not been recognized from New South Wales.

Space precludes figures of all the local species, but those mentioned in Hedley's Check List have all been so well figured and described by him that further description is not necessary. The complete list of New South Wales species is now *Cosa inornata* (Hedley), *C. parallelogramma* (Hedley), *C. pectinata* (Hedley), *C. tatei* (Hedley) *C. sagana* Iredale, *C. pharetra* Iredale *C. stephensensis* Laseron, and *C. auriculata* Laseron.

Cosa stephensensis, sp. nov.

(Figures, 39, 39*a*.)

Shell of medium size, white, subquadrate, rather higher than long, extremely inequilateral, umbos terminally situated, and right above the slightly concave anterior margin, ventral and posterior margins rounded. Prodissoconch large and prominent, flat and disc-like, standing above the main valve from which it is separated by a narrow furrow. Hinge moderately long, chondrophore subumbonal, rather irregular, with a small projection visible in some lights at the anterior end, hinge plate vertically striate posteriorly, posterior margin of shell strongly denticulate, fading to small crenulations on the ventral margin. Sculpture cancellate, the radial the stronger, consisting of 12 equally-spaced narrow rays, indenting the ventral margin, crossed by numerous, narrow concentric ridges, rising to small points where they cross the rays. Height 3·8 mm., fength 2·8 mm.

Locality.—Shell sand, Port Stephens.

Remarks.—This species generally resembles the deep water species, *Cosa pectinata* (Hedley), but is not so rounded in shape, is even more inequilateral, and the radial rays are fewer in number, only 12 instead of 22.

Cosa auriculata, sp. nov.

(Figures 40, 40*a*.)

The shell here figured is from 30—35 fathoms off Crookhaven, its height 2·3 mm., and its length 2·5 mm. The periostracum is moderately thick, covering the whole shell, and extending as a fringe beyond the ventral margin. The sculpture is eight radial rays. The shell is not so inequilateral as others in the group, the umbo is some distance from the anterior end leaving a small auriculate projection. The prodissoconch is large,

flat, round, and separated by a fine groove from the main valve. The hinge line is long and straight, chondrophore wide and narrow, hinge plate vertically striate, the anterior striations few, posterior margin beyond the hinge strongly crenulate, anterior margin smooth. Colour of shell, pale yellow buff.

This shell was at first thought to be *C. sagana* Iredale, (*Rec. Aust. Mus.*, xviii, p. 204.), which Iredale described as follows:— "It differs from all other New South Wales species in being long and broad, and having a very pronounced cap. The sculpture is stronger than that of *Hochstetteria inornata* Hedley which it most approaches, but its hinge line is that of *Cosa*, most like that of *C. tatei*. Eight major rays can be counted, the cancellate sculpture being weak." This species, together with *C. pharetra* Iredale, was described from two unnamed species collected by Hedley from 100 fathoms off Wollongong. No figures were given.

A comparison of *C. sagana* with *C. auriculata*, shows that although the sculpture is similar, the latter can be readily separated by its long hinge line; it is not nearly so inequilateral, and the auricle at the anterior end is distinctive.

Family Limopsidae.

Genus **Austrosarepta** Hedley, 1899.

Genotype, *Austrosarepta picta* Hedley.

Proc. Linn. Soc. N.S.W., 1899, p. 429.

Salient features taken from Hedley's generic description are the amphidetic internal ligament and distinct though feebly separated resilium. The hinge line is arched, the teeth few, and the dorsal margin is crenulated both before and behind. The shell is brightly coloured and subrostrate, and the genotype has a sharp fold proceeding obliquely from the beak to the postero-ventral margin.

In his 1918 Check List Hedley synonymized *Austrosarepta* under Smith's *Lissarca*, but Iredale (1924, p. 186), revived *Austrosarepta* as distinct from *Lissarca*.

Austrosarepta picta is quite a common shell on the coast, both on the outside beaches and in dredgings up to 10 fathoms. Hedley's description is so full and adequate and his figures so accurate that it is unnecessary to repeat or add to them.

Austrosarepta elliptica, sp. nov.

(Figures 41, 41*a*.)

Shell small, uniformly bright red-brown, broadly elliptical and inflated, inequilateral, umbos tumid, all margins rounded. Surface of shell nearly smooth, sculpture confined to faint growth lines, and a few faint oblique transverse ridges which crenulate the posterior ventral margin. There is no keel as in *A. picta*. Hinge line slightly arched with a narrow, transverse, subumbonal depression apparently the position of the internal, amphidetic ligament. In the centre of this area is the distinct triangular resilium. The teeth are few but prominent and protruding, three posterior and three anterior, and beyond these the dorsal margin is strongly crenulated both before and behind. Length 2·5 mm., height 2·3 mm.

Locality.—Not uncommon, 30—35 fathoms off Crookhaven.

Remarks.—From the hinge this is undoubtedly congeneric with *A. picta*, but the hinge is not nearly so sharply arched. Externally the species are easily separated. *A. elliptica* is much more rounded, it lacks the oblique keel which is replaced by faint transverse ridges, and the uniform red-brown colour is a good recognition point.

Family Amphidesmatidae.

Genus **Spondervilia** Iredale, 1930.

Genotype, *Ervilia australis* Angas.

There has been considerable uncertainty about both the identity and systematic position of a rather rare Sydney shell long known to local conchologists as *Ervilia bisculpta* Gould. The type of *Ervilia bisculpta* came from Japan and the occurrence of this species in Port Jackson has always been open to doubt. Angas (1877) described and figured *Ervilia australis* from "Sow and Pigs" bank, Port Jackson, and his description, as far as it goes, fits the shell here considered conspecific, but the figure does not altogether agree with the description, and is also too indefinite and does not show the essential characters. Hedley (1906, p. 479), recorded *E. bisculpta* from the Mast Head Reef, Queensland, and also mentions that it occurs in Sydney Harbour. In his Check List he synonymizes Angas's species *australis* under *bisculpta*. Iredale (1930) restored *australis* and named it as the genotype of a new genus *Spondervilia*. The shell I have taken as *australis* is certainly related to the Queensland shell, but the well known accuracy of Hedley's drawings leaves no doubt that it is a different species, and that the restoration of Angas's *australis* is quite justified. Iredale is quite in agreement with my identification of *australis* and that the specimen here figured is appropriate as the genotype of *Spondervilia*.

Unfortunately, when proposing *Spondervilia*, Iredale gave no generic characters, and merely said that it "does not bear much resemblance to the Palaearctic type of *Ervilia*." In order to clarify the position the following characters are suggested as characteristic of *Spondervilia*.

Shell small, equivalve, closed, nearly equilateral but more or less prolonged anteriorly, umbos turned anteriorly, capped with a small but very prominent dome-shaped prodissoconch, ligament internal, the resilium in a subumbonal pit, hinge with one or two ill-defined cardinals in each valve, laterals present but not prominent. Pallial line not entire, pallial sinus moderately deep. Sculpture variable, but concentric and transverse sculpture both present.

Spondervilia australis Angas.

(Figures 44, 44*a*, 44*b*.)

Hedley 306.

This small white shell may be recognized by its form and sculpture, the bulk of the shell with faint concentric growth lines, with fine, continuous, transverse ridges at the anterior end. The margin of the transverse sculpture is marked by a faint keel sloping from the umbo to the anterior ventral margin, the keel more prominent dorsally near the umbo. The specimen figured was dredged in Manly Cove, Port Jackson; its dimensions are length 5·2 mm., height 2·9 mm.

Spondervilia rubra, sp. nov.

(Figures, 42, 42*a*, 42*b*.)

Shell minute, thin, bright pink, subtranslucent, elliptical, nearly equilateral, anterior end narrowed, umbos prominent, pointing anteriorly, prodissoconch small but very prominent, dome-shaped and brown. Adductor scars and pallial line indistinguishable. Resilium narrow and deep, centrally situated, left valve with an obscure narrow cardinal and well defined laterals, right valve with a large but obscure cardinal and well defined laterals. Sculpture distinctive, the whole surface covered with both concentric and transverse very fine ridges which, where they cross, are seen under the microscope to rise into minute tubercles. Length 2·5 mm., height 1·7 mm.

Locality.—Long Reef, collected by Miss Duff.

Remarks.—The bright pink colour, the general form and sculpture should make this species easy for future recognition. It is rather doubtfully placed in *Spondervilia*, but the form of the shell and particularly the prodissoconch suggest close relationship.

Spondervilia simplex, sp. nov.

(Figures 43, 43*a*.)

Shell very small, white, thin, subtranslucent, nearly equilateral, elliptical, umbos nearly erect, small, pointed slightly anteriorly, prodissoconch very small but very prominent, dome-shaped, very pale brown. Anterior end of shell narrowed but not so much as in *S. rubra*. Adductor muscle scars faint, pallial sinus just discernible. Resilium in both valves placed in a deep but narrow pit, each valve with an obscure cardinal and laterals, the anterior lateral in the left valve prominent and projecting. Sculpture both concentric and transverse, consisting of very fine ridges covering the whole of the shell, and where they cross rising into minute tubercles, visible only under high magnification. Length 2·8 mm., height 2·4 mm.

Locality.—Ocean Beach, Manly (type); North Harbour, Port Jackson; Caloundra, Queensland (J. Laseron.)

Remarks.—Closely allied to *S. rubra*, from which it may be readily separated by its colour, broader outline, particularly anteriorly, by its smaller prodissoconch, and more erect umbos.

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FOSSIL MECOPTEROID INSECTS FROM THE UPPER PERMIAN OF NEW SOUTH WALES.

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(Plates v—vi; Text-figures 1–167.)

This paper deals with the Mecoptera and all the related orders of insects collected from the Upper Permian strata between Belmont and Warner's Bay, New South Wales. All the material described is in the Collection of the Australian Museum, Sydney. Tillyard published several papers dealing with the early collections of insects from these beds but the more recent and rather extensive collections remain unworked except mainly for the Homoptera and Psocoptera. The present material extends considerably our knowledge of the previously described species and has brought to light a great wealth of new forms.

Tillyard, in his papers on the orders under consideration, allowed practically no variation within a species and was often led astray by irregularities in the preservation of the specimens. It is considered, from a study of very long series, that these Permian species showed considerable variation and also that great care must be taken to allow for the effects of preservation.

Of the Mecopteroid orders the true Mecoptera are dominant in the fauna. In addition to Eumecoptera there are the primitive suborders Protomecoptera and Paramecoptera as well as the Protodiptera which also are best considered within the Mecoptera. The Neuroptera are represented by a number of interesting types. Trichoptera are recognized from these beds for the first time, and this, I believe, is the first record of the order from Permian strata.

I greatly appreciate the opportunity to study this material for which I am grateful to the Director and staff of the Australian Museum; to Mr. O. le M. Knight (who collected a considerable portion of the material) for the loan of literature, and to the Chief of the Division of Entomology, C.S.I.R.O., for permission to devote a little of my official time to the study of fossil insects.

Order MECOPTERA.

This order is expanded to include not only the Eumecoptera but all the Mecopteroid forms which do not fall into any of the recognized living orders. In the suborder Protomecoptera, which includes the families Platychoristidae and Permomeropidae, and the suborder Paramecoptera, CuA is forked in the forewing. In the other fossil suborder, Protodiptera, CuA is simple in both wings. The Paratrichoptera were inaccurately diagnosed by Tillyard and are considered as a family within the Eumecoptera.

Suborder PROTOMECOPTERA.

Tillyard first used the name Protomecoptera for the Triassic *Archipanorpa*. This genus shows a distinct costal vein so that its Mecopterous affinity is doubtful. Subsequently the group was expanded to include *Platychorista* and *Permomerope*. The Recent genera *Merope*, *Austromerope* and *Notiothauma* are also included in the suborder. The name is best retained in the altered sense to include all the above genera except *Archipanorpa*.

Forewing.—CuA forked, anals looped, a complete series of costal veinlets, veins with many branches.

This suborder differs from typical Mecoptera chiefly in the looped anals and forked CuA. It is separated from the Trichoptera because of the many branches to the veins and in general, on the complete series of costal veinlets. CuA is not regularly, strongly bifid, as in Trichoptera.

Family PERMOMEROPIDAE, nov.

Allied to the Permian Platychoristidae but differing in the type of forking to CuA and the more regularly dichotomic branching of Rs and M. There is only one genus from the Upper Permian of New South Wales.

Forewing.—Costal space broad, with a number of oblique veinlets from Sc to the costal margin; pterostigma well-developed; Rs and M with numerous dichotomous branches; CuA forked near apex, not regularly strongly bifid; CuP simple; 1A simple, 2A looped on to 1A and 3A on to 2A.

Hindwing.—Costal space with a number of oblique veinlets from Sc to the costal margin; pterostigma well-developed; Rs and M with numerous dichotomic branches; CuA forked near apex, not regularly bifid.

The family might better be placed in the Planipennia on the structure of CuA which is sometimes pectinately branched near its apex. The family Permosisyridae of the Russian Permian shows the transition to the Planipennia even more distinctly. One species, *Permosisyra punctata* Martynov, 1933, is very close to *Permomerope* but the species *Permosisyra latipennis* is distinct and a true Planipennia.

Genus **Permomerope** Tillyard, 1926.

Genotype *Permomerope australis* Tillyard, 1926.

Forewing.—Costal space slightly expanded over the basal half; Rs dichotomously branched, branches numerous (14); M normally eight-branched; CuA forked at least once near apex.

Hindwing.—Costal space narrow basally; Sc not reaching the pterostigma but fused to R_1 just before the pterostigma; pterostigma well-developed, lying in the apical fork of R_1; Rs with fewer branches than in the forewing, variable in their arrangement, but generally dichotomously branched; M generally with eight regularly dichotomous branches; cubito-median Y-vein not clearly preserved; CuA forked at least once, generally twice, near apex.

The genus differs from *Cladochorista* (Order Trichoptera) mainly in the extra forking to all veins, in the development of a distinct pterostigma and in the irregularly forked CuA.

Permomerope australis Tillyard, 1926.

(Plate v, B, figs. 6–7; Text-figs. 1–3.)

Permomerope australis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 275.

Forewing.—Long, length of fragment 10 mm., rather narrow, apex fairly sharp; costal space not markedly expanded, costal veinlets evenly spaced, more oblique towards the apex; R kinked slightly at the base before the origin of Rs; pterostigma and apex of Sc not preserved; Rs fourteen-branched, with an occasional branch showing an additional end-twigging, origin of the branches not preserved but apparently arising dichotomously; M eight-branched, the first fork well towards the base, M_{3+4} forking well before M_{1+2}; cubito-median Y-vein area not preserved; CuA three- or four-branched near its apex, with a distinct cross-vein to M close to the apical fork; CuP parallel to and well-separated from CuA; 1A close to CuP, simple, reaching the wing margin, 2A looped on to 1A near its apex and with a branch to the wing margin, 3A similarly looped on to 2A; cross-veins preserved at various levels between the branches of Rs.

Hindwing.—Long, length of fragment 8·5 mm., broader than forewing, apex well rounded; costal veinlets evenly spaced, usually more oblique towards the apex; pterostigma strongly formed, without definite veinlets, bordered by a branching of R_1 around it; R_1 straight until the pterostigma, where it takes a decided bend; Rs dichotomously branched, with ten branches, the extra two branches being on the forks of R_5; M regularly eight-branched, M_{3+4} forking well before M_{1+2}; cubito-median Y-vein area not preserved; CuA three-branched near its apex.

Type.—Holotype, fragment of hindwing, F.28045 in the Australian Museum Collection (No. 100 of Mitchell Collection). The counterpart of the type is in the Cawthron Institute. The forewing is described from F.40108, Australian Museum Collection.

There are two additional specimens of this species. F.41239 and counterpart F.41274 is a laterally compressed complete insect but the venation of all wings is confused. F.43119 and counterpart F.43120 shows clearly the structure of the posterior half of the wing, including the looped anal veins.

Permomerope nanus, sp. nov.
(Text-fig. 4.)

Forewing.—Small, length of complete wing 7·5 mm., long, rather narrow, apex rounded; costal space not greatly expanded, Sc ending well before the apex of the wing, connected to R_1 by a short cross-vein; pterostigma well-developed; Rs dichotomously branched, eight-branched, the forking of R_3 reduced, the other three veins with a more pronounced fork; M eight-branched, forking before the forking of Rs, M_{3+4} forking before M_{1+3}; basal origin of Cu not distinct, CuA forked towards apex, a distinct cross-vein to M_{3+4} near origin of fork; CuP simple; 1A simple, reaching the wing margin very close to CuP, 2A simple, looped on to 1A, 3A looped on to 2A.

Type.—Holotype forewing F.40233 in the Australian Museum Collection.

This species differs from preserved portions of *australis* not only in size but also in the reduced branching of Rs and CuA. It shows very clearly the looping of the anal veins.

INSERTAE SEDIS.

Genus **Aphryganoneura** Tillyard, 1926.

Genotype, *Aphryganoneura anomala* Tillyard, 1926.

"Distinguished from all other Mecoptera by the branches of the main veins being parallel, separated by grooves as in Neuroptera Planipennia, and unbranched distally ——————". Branches very numerous.

Aphryganoneura anomala Tillyard, 1926.

Aphryganoneura anomala Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 276.

Type.—Holotype F.28050 and counterpart F.29033 in the Australian Museum Collection.

There are no additional specimens of this species.

Suborder PARAMECOPTERA.

Similar to Eumecoptera, but CuA normally forked in forewing, simple in hindwing; anal veins not looped; cubito-median Y-vein very prominent, arms almost equal; Rs typically six-branched and M four-branched. This suborder may be ancestral to the Hymenoptera.

Family BELMONTIIDAE.

Belmontiidae Tillyard, 1919, 1922, 1926; Martynova, 1942.

Parabelmontiidae Tillyard, 1922, 1926; Martynova, 1942.

Insects of rather large size.

Forewing.—Costal space not very broad and with very few cross-veins; Rs with more branches than M, normally six-branched; M four-branched; cubito-median Y-vein strongly formed; CuA typically forked apically, CuP simple; anal veins simple, connected by cross-veins.

Hindwing.—Similar to the forewing but shorter and broader; Rs seven-branched (this may be a variant); CuA simple; cubito-median Y-vein distinct.

The family contains the two genera *Belmontia* (forewing) and *Parabelmontia* (hindwing), which will probably become synonymous when a complete insect is found.

Genus **Belmontia** Tillyard, 1919.

Genotype, *Belmontia mitchelli* Tillyard, 1919.

Forewing.—Costal space narrow, not expanded near base; Sc forked near its apex, connected to R_1 by a cross-vein; no distinct pterostigma; R_1 simple, Rs six-branched, R_1 and R_4 simple; M four-branched; occasionally five-branched; cubito-median Y-vein well-developed; CuA normally forked near apex, CuP simple; anal veins simple, connected by cross-veins.

Hindwing.—Not known definitely.

Belmontia mitchelli Tillyard, 1919.

(Plate v, B, figs. 12–13; Text-figs. 5–6.)

Belmontia mitchelli Tillyard, 1919, Proc. Linn. Soc. N.S.W., xliv, 234.

Forewing.—Wing of rather large size, length 18 mm., narrow at base, with a slightly pointed apex; Sc branched over its apical quarter or more, one or two costal veinlets before the forking of Sc, the veinlets less oblique; R_1 simple; Rs arises rather close to the base, stem of Rs long, R_{2+3} forking early and R_3 branching again before the wing margin; R_{4+5} branches very close to its origin, before R_{2+3} and R_5 fork again; M four-branched, M_{1+2} forking after M_{3+4}; cubito-median Y-vein large, the arms almost equal; a well-developed cross-vein between M and CuA near the forking of CuA; CuA forked close to the wing margin; CuP simple, distinct; 1A, 2A and 3A simple, connected by cross-veins.

Type.—Holotype forewing F.28469 in the Australian Museum Collection (No. 40 of Mitchell's Collection).

There is a second almost complete wing, F.40970, referred to this species. The costal margin is missing and CuA_1 appears as a fork on M_4 with CuA appearing simple.

Tillyard's figure of the type is inaccurate in some respects. The basal cross-vein connecting M to the stem of R is not distinguishable. The fork shown to R_4 is really a cross-vein to the fork of R_3, which vein was regarded as simple. There is no second branch to R_{5b} or to M_4. This interesting fossil species with its typically forked CuA differs from Trichoptera mainly in the unlooped condition of the anal veins but the very large cubito-median Y-vein is also distinctive.

Genus **Parabelmontia** Tillyard, 1922.

Genotype, *Parabelmontia permiana* Tillyard, 1922.

Forewing.—Not known definitely.

Hindwing.—Costal space narrow, not expanded near the base; no distinct pterostigma; R_1 simple, Rs six- or seven-branched; M four-branched; cubito-median Y-vein distinct; CuA simple, CuP simple; anal veins simple.

This genus, which is very probably the hindwing of *Belmontia*, differs from it only in the simple CuA and the shape of the cubito-median Y-vein. If *Parabelmontia permiana* is considered a forewing, then there is no character on which it can be retained in the Paramecoptera.

Parabelmontia permiana Tillyard, 1922.

(Plate v, B, fig. 14; Text-fig. 7.)

Parabelmontia permiana Tillyard, 1922, Proc. Linn. Soc. N.S.W., xlvii, 286.

Hindwing.—Wing of rather large size, length 18 mm., broad, apex rounded; Sc forked over at least the apical half, the branches oblique, particularly the apical one; R_1 forked at apex, lying close to Sc; Rs seven-branched, R_2 simple, R_{4+5} forks before R_{2+3} and the branches of R_3 reunite before the wing margin (as an individual variation); M four-branched, M_{1+2} forking after M_{3+4}; cubito-median Y-vein distinct, with the branch from M strongly developed and continuing straight as CuA to the wing margin; CuP simple, widely separated from CuA; three simple anal veins, 3A quite small and strongly curved.

Type.—Holotype hindwing F.28461 in the Australian Museum Collection. (No. 54 of Mitchell's Collection.)

F.41188 is a rather crumpled fragmentary wing of this species. Tillyard's figure of the type is inaccurate in many details, most notably in the structure of M. This vein shows the typical four-branched condition, the extra forks shown on M_1 and M_3 are not present in the fossil. The lower arm of the cubito-median Y-vein is simple and there is no sign of an apical cross-vein between CuA and CuP.

Suborder EUMECOPTERA.

Five families of this suborder have been recognized in these beds. The Mesochoristidae, Agetopanorpidae and Xenochoristidae contain species of moderate size but in the Mesopanorpodidae and Nannochoristidae the species are from small to minute.

If one considers the total number of specimens then the Mesochoristidae is the dominant family. However, it contains only a few species, one of which is represented by about one hundred and fifty specimens. The very small Mesopanorpodidae are abundant but the other three families are represented by very few specimens.

Family MESOCHORISTIDAE Tillyard.

Insects of from moderate to rather large size.

Forewing.—M six-branched, with extra forks on M_2 and M_4; Rs variable, four- to six-branched, often tending to pectination; Sc two-branched.

Hindwing.—M four-branched; Sc forked near apex; R as in the forewing.

Two genera occurring in these beds, *Mesochorista* and *Parachorista*, are placed in this family which, in its restricted redefinition, is almost entirely confined to Australia. In *Mesochorista* Rs is typically four-branched while in *Parachorista* it is six-branched, pectinate. Species of *Parachorista* are of rather large size, while those of *Mesochorista* are more generally of medium size but some are quite small.

Genus **Mesochorista** Tillyard, 1916.

Genotype, *Mesochorista proavita* Tillyard, 1916.

Genotype, *Mesochorista proavita* Tillyard, 1916.

Mesochorista Tillyard, 1916.

Permochorista Tillyard, 1917, 1922, 1926.

? *Petrochorista* Martynov, 1931 (in part).

Forewing.—Sc forked, two-branched; Rs four-branched, R_{4+5} forking before R_{2+3}; M six-branched, the extra forks on M_2 and M_4; CuA simple; cubito-median Y-vein variable; CuP and anals simple, except 3A which is forked close to its base.

Hindwing.—Sc shorter, simple; R as in forewing; M only four-branched; CuA simple; CuP and 1A fused for part of their length; 2A and possibly 3A simple.

There is some variation in the forking of Rs and M, in both wings, the number of branches being either increased or reduced.

Most of the Russian species referred to this genus have a three-branched Sc in the forewing and should be considered preferably in the genus *Petromantis* Handlirsch. The hindwing differs from *Mesochorista* in having a five-branched media. Tillyard separated the Permian species generically from *Mesochorista proavita* from the Triassic on very slight characters which are considered to be only of specific value.

Mesochorista australica (Tillyard), 1917.

(Plate v, A, figs. 1–17; Text-figs. 8–17.)

Permochorista australica Tillyard, 1917, Proc. Linn. Soc. N.S.W., xlii, 733.

Permochorista mitchelli Tillyard, 1917, Proc. Linn. Soc. N.S.W., xlii, 734.

Permochorista sinuata Tillyard, 1922, Proc. Linn. Soc. N.S.W., xlvii, 287.

Permochorista affinis Tillyard, 1922, Proc. Linn. Soc. N.S.W., xlvii, 288.

Permochorista collinsi Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 269.

Permochorista pincombei Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 269.

Permochorista angustipennis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 270.

Permochorista osbornei Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 271.

Permochorista inaequalis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 272.

Forewing.—Wing of moderate size, length about 10 mm., costal space slightly expanded, apex evenly rounded; Sc long, forked after the origin of Rs, the lower branch extending well beyond the upper branch, ending on the wing margin at or included in the pterostigma; a distinct cross-vein from Sc_2 to R_1 well before the pterostigma; humeral cross-vein distinct, close to base; R_1 simple, sigmoid, concave at the origin of Rs, convex just before the pterostigma and then concave again around the pterostigma; pterostigma well-defined, extending below R_1 but not touching R_2, basal margin more or less truncate; subcostal space wide at origin of Rs; Rs arising at junction of basal and middle thirds of R, four-branched, R_{4+5} forking well before R_{2+3}; M arising close to base, at least before the humeral cross-vein, six-branched, forking at or before the forking of Rs, with M_{3+4} forking well before M_{1+2}, extra forks on M_2 and M_4; cubito-median Y-vein distinct, the arms tending to be equal but the cubital branch the longer; CuA straight over its basal half, sigmoidally curved over the apical half, with a distinct cross-vein to M_4 close after its origin; CuP simple, converging slightly to CuA except at its apex; a distinct cross-vein to CuA about halfway from the cubito-median Y-vein to the wing margin, 1A and 2A simple, 3A forked close to its base; a short jugal vein also present; cross-veins rather widely dispersed between most branches of the veins; macrotrichia present on the main veins, including CuP.

Hindwing.—Similar in shape to forewing but costal margin straighter and hind margin a little more rounded; costal area not expanded; Sc shorter than in forewing, simple, slightly curved away from R, ending on wing margin soon after the first forking of Rs, from close to its apex a very distinct cross-vein to R_1, humeral cross-vein as in forewing;

R_1 almost straight, a slight kinking near the level of the humeral cross-vein, forked at apex, both branches enclosed in the distinct pterostigma; Rs arising rather closer to the base than in the forewing, four-branched, forking of R_{4+5} before R_{2+3} but both forking well before the wing margin; M arising from the stem of R before the level of the humeral cross-vein, four-branched, forking at or before the level of the first forking of Rs, M_{3+4} forking before M_{1+2}; cubito-median Y-vein not present, CuA fused to M for a short distance, continuing the basal line of M to the wing margin so that M appears as a branch of CuA; CuA very gently sigmoidally curved, CuP simple, almost parallel to CuA; 1A fused to CuP over most of its basal half, apical half free and also the extreme base; 2A simple, 3A apparently simple.

Type.—Holotype F.39318 in the Australian Museum Collection (No. 24 of Mitchell's Collection). The types of *sinuata* F.38270 and counterpart F.28463 (paratype F.28460); *pincombei* F.19796; *angustipennis* F.28043; *affinis* F.28466; *mitchelli* F.39317; *collinsi* F.28042 and counterpart F.29031 and *inaequalis* F.19792 are also in the Australian Museum Collection. The type of *osbornei* is stated to be in the Cawthron Institute Collection.

There are 140 additional specimens of this species. Most are isolated wings or wing fragments but a few show overlapping fore and hindwings. The body and legs are unknown. This species is dominant in the fauna and it is remarkable that no body structures were preserved.

There are many inaccuracies in the figures of the types given by Tillyard. It was only after an examination of the original specimens, with the exception of *osbornei*, that the above synonymy was established.

There is some variation in structure, particularly in the branching of M and, to a less extent, of R and the cubito-median Y-vein. Three specimens show a seven-branched media, the extra branch being on M_1, M_3 or M_4. Six specimens show a reduced branching, M being only five-branched with M_2 simple. The type of *mitchelli* shows this condition. In F.40139, though M is six-branched, the forking of M_2 is reduced to a small twigging. Rs is fairly constant in structure. In only two specimens is there a reduced branching of R_{2+3}. F.40139 shows this vein forked near the margin; F.40131 has lost the apex of the wing and the vein appears simple but it is possibly forked close to the margin. In the type of *collinsi*, F.29031, R_2 shows an additional twigging, Rs being five-branched, and the same condition occurs in two other specimens, in F.40196 and counterpart F.40212 and in F.40225.

F.41700, F.40201 and F.43137 show associated fore and hindwings. F.40208 and counterpart F.40195 has four partly overlapping wings, both forewings with only a five-branched media and hindwings normal for the species.

There is some variation in the hindwings, notably in the position of the fork on R_{2+3}. One specimen, F.40213 and counterpart F.40215, shows a small extra fork on M_2 but has the typical forking of R_{2+3}. The holotype of *inaequalis* Tillyard, F.19792, is a hindwing.

The wing pigmentation pattern is preserved in some specimens, notably F.39982, F.40149 and F.40124. It is different in all three specimens but as it is impossible to distinguish them on venational characters there is no value in separating them specifically because the great majority of specimens are preserved without pattern.

At first it might be considered that forms with only a five-branched media in the forewing belong in the family Neorthophlebiidae but they differ markedly from such species in the expanded costal margin, distinctly dichotomic Sc and in having CuA and M either just touching or with a very reduced cubito-median Y-vein. The Neorthophlebiidae may have arisen through such a form as *Mesochorista* but certainly not along this line. The affinity to the Recent Choristidae is marked and had such a specimen occurred on its own it would undoubtedly have been considered in that family as a genus differing only in the structure of Sc, this vein being less distinctly forked in the Recent forms though, on rare occasions, such a condition does persist.

One specimen, F.40208 and counterpart F.40195, shows this five-branched media in both wings. Both hindwings are preserved and these have the normal four-branched media of the Mesochoristidae and Choristidae. On this example there would be some justification in considering it within the Choristidae, but preferably all these forms should be considered (and those with other variations of M) within a very variable species of *Mesochorista* which has reached an incipient stage of speciation.

Mesochorista jucunda (Tillyard), 1926.
(Plate v, B, figs. 4–5; Text-figs. 18–19.)

Permochorista jucunda Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 268.

Forewing.—Wing of moderate size, length 7 mm., rather long and narrow, costal space only slightly expanded, apex evenly rounded; Sc long, forked after the origin of Rs, the lower branch extending for almost the length of the stem, almost parallel to R_1; Sc_2 ends at the pterostigma; a distinct cross-vein from Sc to R_1 after the origin of Sc_2; R_1 simple, with a slight sigmoid curvature, concave at the origin of Rs but almost straight for the remainder of its length; pterostigma distinct, extending below R_1; subcostal space widest at the origin of Rs; Rs arising a quarter of the wing length from the base, four-branched, R_{4+5} forking before R_{2+3}, both forks very long; M arising close to the base of the wing, at least before the humeral cross-vein, six-branched, forking at or before the forking of Rs, with M_{3+4} forking well before M_{1+2}, extra forks on M_2 and M_4; cubito-median Y-vein not present, CuA touching or fused to M for a short distance or, if present, with arms very unequal; CuA with a slight sigmoid curvature over its apical third; CuP almost straight, slightly curved at apex; 1A and 2A simple, 3A possibly forked near base.

Hindwing.—Costal area narrower than in forewing, hind margin more rounded; Sc short, simple, ending on the costal margin about the first forking of Rs, with a distinct cross-vein to R_1 from near its apex; R distinctly concave at the origin of Rs, then continuing, almost parallel to the anterior margin, till near its apex; R_1 simple, though it is possible that there are weak cross-veins to the costal margin at the pterostigma; pterostigma clearly defined, extending well below R_1; Rs arising well towards the base of the wing, four-branched, similar to the forewing; M arising close to the base, before the curvature of R, four-branched, forking at or before the first forking of Rs, M_{3+4} forking before M_{1+2}; cubito-median Y-vein not present, CuA fused to M for a short distance, continuing the basal line of M to the wing margin so that M appears as a branch of CuA; CuA straight; CuP simple, free from 1A over more than its apical half; 1A simple fused almost basally to CuP; other anal veins not preserved.

Type.—Holotype F.38269 in the Australian Museum Collection (No. P.167 of Pincombe's Collection). The counterpart of the type is also in the Australian Museum. Collection, F.29032, and not in the Cawthron Institute Collection.

There are a number of additional specimens. F.40209 and counterpart F.41183 is a perfect wing which does not preserve the jugal region and 3A appears simple; F.41383 is perfect except for a little of the costal and apical margins and the jugal region; F.40221 lacks only the extreme apex of the wing and a small portion of the anal veins; F.41114 is an almost perfect wing; F.41748 has fore- and hindwings super-imposed; F.41189, F.40135, F.41195, F.41322 and counterpart F.41321 and F.41365 are more fragmentary. The description of the hindwings is based on F.42495, which lacks both the extreme base and the apex.

This species is similar to *australica* but differs in having a narrower wing in which the costal space is not expanded. The forking of Sc in the forewing is very different. In the hindwing Sc is shorter and R_1 not obviously forked near its apex. Without an almost complete wing it is hard to separate the two species but *jucunda*, on the average, is much smaller than *australica*.

Mesochorista dubia, sp. nov.

(Plate v, B, fig. 3; Text-fig. 20.)

Forewing.—Wing of moderate size, length 9·5 mm., costal space expanded somewhat over the basal half, apex rounded, greatest width well beyond the middle; Sc long, extending into the pterostigma, two-branched, branching at about its middle; R_1 simple, gently sigmoidally curved; pterostigma distinct, but margins not sharply defined; Rs arising towards the base of the wing, four-branched, its stem short, R_{2+3} forking very early, not much after R_{4+5} so that all four branches are extremely long; M arising from close to the base of the wing, six-branched, the first forking at a level with the first forking of Rs, M_{3+4} forking again very early, well before M_{1+2}, extra forks on M_2 and M_4; cubito-median Y-vein not present, CuA and M fused for a short distance; CuA simple; with a slight sigmoid curvature over its apical third; CuP simple, weak, well-separated from CuA (partly obscured by a slight fold of the wing membrane); 1A and 2A long, simple, subparallel, 3A apparently simple, also long and subparallel to 2A.

Type.—Holotype forewing F.41287 in the Australian Museum Collection.

F.42108 and counterpart F.42109 is referred only provisionally to this species, for in this specimen the forking of R_{2+3} is closer to the wing margin. The species differs from *jucunda* in the branching of R_{2+3} and in its larger size.

Mesochorista phipa, sp. nov.

(Plate v, B, figs. 1–2; Text-fig. 21.)

Forewing.—Wing small, length 6 mm., costal space not expanded, apex evenly rounded, greatest width well beyond the middle of the wing; Sc long, forked after the origin of Rs, the upper branch appearing almost as a cross-vein, lower branch long, ending before the pterostigma and with a cross-vein to R_1 from near its apex; R_1 simple, sigmoidally curved near base, straight over its apical half; pterostigma small but distinct, with R_1 passing through its middle; subcostal space widest at origin of Rs; Rs arising less than a third the length of the wing from the base, four-branched, R_{4+5} forking before R_{2+3}, both forks long; M arising from the stem of R close to the base of the wing, six-branched, forking well before the first forking of Rs, M_{3+4} forking well before M_{1+2} and before the first forking of Rs, extra forks on M_2 and M_4; cubito-median Y-vein not present, M and CuA fused for a distance; CuA with a slight curve near the wing margin; CuP simple, weak; 1A and 2A simple, 3A as preserved simple, possibly forked near origin.

Type.—Holotype F.40125 and counterpart F.40180, a complete forewing in the Australian Museum Collection. There are no additional specimens.

This species is smaller than the others of the genus. It shows a different branching of M_{3+4} and Sc is distinctive, as is also the more complete fusion of M and CuA near their bases. It is closely allied to *jucunda*, but has a different forking of Sc and more fusion of M and CuA.

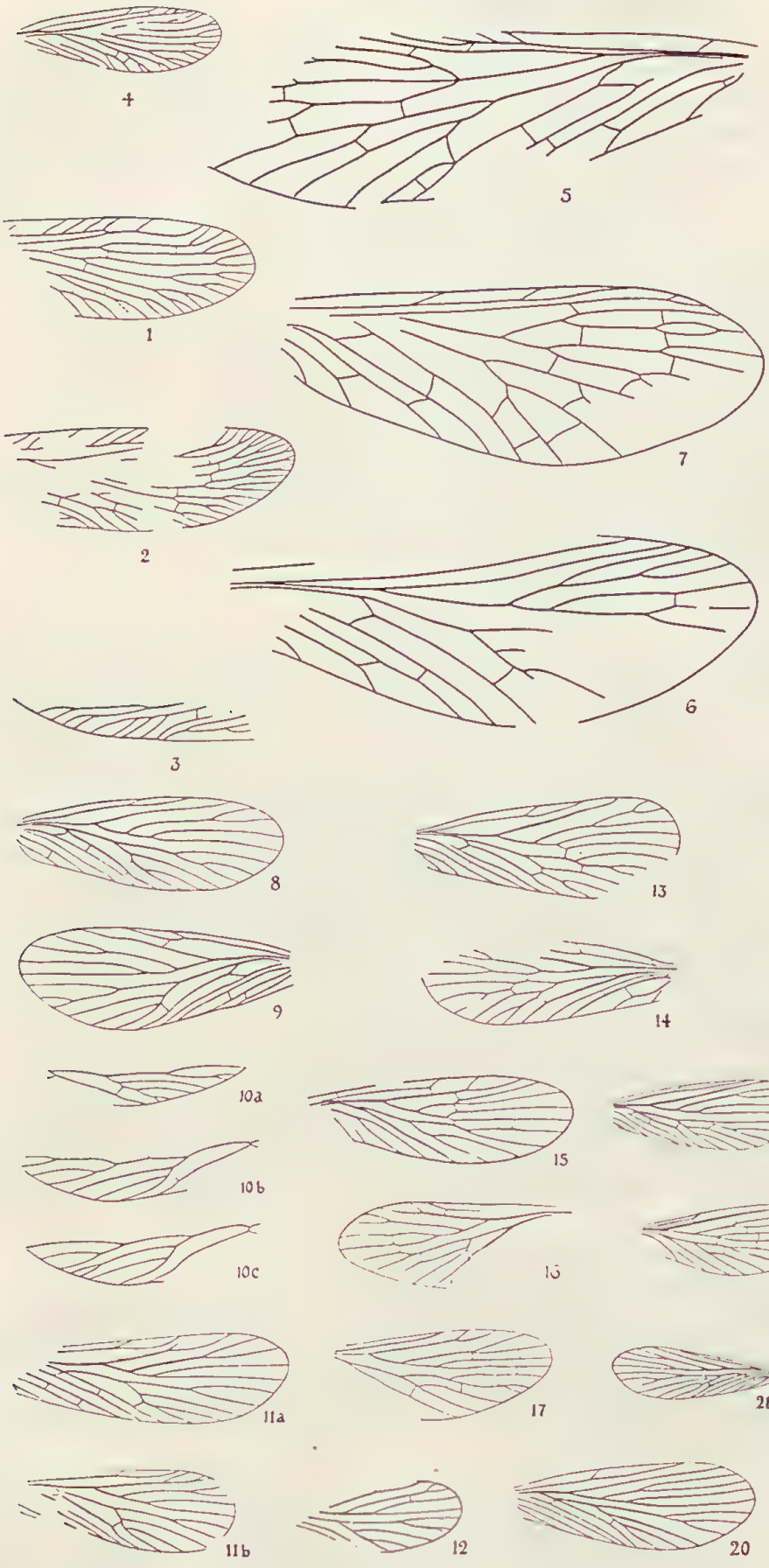
Genus **Parachorista** Tillyard, 1926.

Genotype, *Parachorista pincombeae* Tillyard, 1926.

Forewing.—R_{2+3} forming a pectinate series of four or occasionally only three branches; R_{4+5} branching only into R_4 and R_5; M six-branched, the extra forks being on M_2 and M_4; CuA and anal veins simple; cubito-median Y-vein distinct.

Hindwing.—R branching similar to forewing; M only four-branched; CuA fused to M for a short distance.

Martynov (1932 and 1940) has described two species and Martynova (1942) one species of this genus from the Russian Permian, but they differ markedly in the branching of M and the structure of Sc and R_1 and are best considered generically distinct. The extra fork on Rs may be only an individual variation in which case the specimens would fall within the group of species they have placed in *Permochorista* which already have been shown to differ generically from the Australian species.



Text-figures 1–7.

All figures x 3 ca.

1, F.28045, holotype of *Permomerope australis* Tillyard.—2, F.40108, forewing of *Permomerope australis* Tillyard.—3, F.43119, *Permomerope australis* Tillyard.—4, F.40233, holotype of *Permomerope nanus*, sp. nov.—5, F.28469, holotype of *Belmontia mitchelli* Tillyard.—6, F.40970, *Belmontia mitchelli* Tillyard.—7, F.28461, holotype of *Parabelmontia permiana* Tillyard.

Text-figures 8–21—*Mesochorista* spp.

All figures x 3 ca.

8–17, *Mesochorista australica* (Tillyard). 8, F.41286.—9, F.40189.—10, *a*, F.40176; *b*, F40229; *c*, F.40141. Variants of M, with seven branches.—11, *a*, F.40301; *b*, F.39317 (holotype of *mitchelli*). With simple M_2.—12, F.40139. Reduced branching of R_2+_3 and of M_2.—13, F.29,031 (holotype of *rollinsi*). Additional branch on R_2.—14, F.43122, Reduced branching of $R+_5$.—15, F.40132, Hindwing with deeply forked R_2+_3.—16, F.40224, Hindwing with reduced forking on R_2+_3.—17, F.40213, Hindwing with extra fork on M_2. 18, F.38269,holotype of *Mesochorista jucunda* (Tillyard).—19,F.42495,? hindwing of *Mesochorista jucunda* (Tillyard).—20, F.41287,holotype of *Mesochorista dubia*, sp. nov.—21, F.40125, holotype of *Mesochorista phipa*, sp. nov.

There are two species of the genus in these beds; one is based on the forewing and the other on the hindwing, so it seems most probable that there is really only a single species. As the hindwing is a little larger than the forewing the two specific names have been retained.

Parachorista pincombeae Tillyard, 1926.

(Plate v, B, figs. 10–11; Text-figs. 22–23.)

Parachorista pincombeae Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 273.

Parachorista warnerensis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 273.

Forewing.—Wing rather large, length of preserved portion 12 mm., apex evenly rounded; Sc forked towards apex, two-branched only; costal space not markedly widened over basal half; R_1 simple; pterostigma well developed, large, extending well below R_1, almost touching R_3; stem of Rs rather short, Rs six-branched, R_{4+5} branching early, slightly before R_{2+3}, R_2 three-branched, forming with R_3 a pectinate series; M six-branched, with extra forks on M_2 and M_4, with M_{3+4} forking well before M_{1+2}; cubito-median Y-vein distinct, the cubital branch the longer; CuA simple, slightly sinuated near the wing margin; CuP simple, connected to CuA by a cross-vein about the middle of its length or somewhat before the middle; 1A and 2A simple, 3A not preserved.

Type.—Holotype forewing F.38272 and counterpart F.28041 in the Australian Museum Collection. (Holotype No. 83 of Mitchell's Collection, counterpart No. 55 of Pincombe's Collection.) The type of *warnerensis* Tillyard (No. P.164 of Pincombe's Collection) is also in the Australian Museum Collection, F.28049.

There is a further fragmentary specimen, F.43110, of this species. Tillyard's figure of *warnerensis* is quite inaccurate. The forking of M is identical with that of *pincombeae*, the extra forks being on M_2 and M_4, not on M_2 and M_3 as figured. R_1 is simple in both specimens.

Parachorista splendida Tillyard, 1926.

(Plate v, B, figs. 8–9; Text-fig. 24.)

Parachorista splendida Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 274.

Hindwing.—Wing rather large, length 15 mm., triangular, with the apex somewhat pointed; costal space narrow; Sc simple, but with an apical cross-vein to R_1, ending a little before the pterostigma; R_1 forked at apex and with the lower branch bent around the pterostigma; stem of Rs rather short, R_{2+3} forking at or before the forking of R_{4+5}, R_2 forking again to give a five-branched Rs; M four-branched, M_{3+4} forking well before M_{1+2}; cubito-median Y-vein absent, CuA and M fused for a distance; CuA simple, CuP simple, fused to 1A for part of its length; 1A, 2A and 3A all simple, connected by single cross-veins.

Type.—Holotype hindwing F.28048 and counterpart F.28462 in the Australian Museum Collection. (Holotype No. 107 of Mitchell's Collection.) Specimen No. 108*a* of Mitchell's Collection is the counterpart of the type, though no mention is made of it in the original description.

There are a further two specimens of this species, F.41023 and F.41094. In both, Rs is six-branched, but in other characters they are similar to the type. Sc is not quite so sharply angled at the cross-vein to R_1. The pterostigma is clearly defined in each of these specimens and shows a truncate base, more or less parallel to the branch of R_1.

Family AGETOPANORPIDAE Carpenter, 1930.

Allied to the Mesochoristidae on the typically six-branched media but, in general, differing in the branching of Sc and Rs.

Forewing with Sc three-branched, dichotomic, the branches long; M normally six-branched, with extra forks on M_2 and M_4 or rarely five-branched (*Agetochoristella*, gen. nov.) with an extra fork only on M_2; Rs four-branched, or five-branched with R_2, R_3 or R_5 forking; cubito-median Y-vein normally distinct.

From these Upper Permian beds four new genera are placed in this family mainly because of the three-branched Sc. In three of them the media has the normal six branches but in the fourth, *Agetochoristella*, gen. nov., M is only five-branched in the forewing, as well as in the hindwing.

The family is dominant in the Upper Permian of Russia where there are several genera including *Petromantis* Handl. and *Agetochorista* Mart. (syn. *Oochorista* Mart.). The family also occurs in the Lower Permian of Kansas, being represented by the genera *Agetopanorpa* Carpenter and *Protochorista* Till. (syn. *Protopanorpa* Till.).

The genera grouped in the family show a very diverse branching of Rs but all have a three-branched Sc and, except for the one genus, a six-branched M, with the extra branches on M_2 and M_4. The hindwing, where known, has a five-branched M with the extra fork on M_2 and this condition occurs in both the fore and hindwings of *Agetochoristella*. There is a group of genera with Rs five-branched, with the extra fork on R_5, as in *Agetopanorpa*, *Agetochorista* and *Neoageta*. In *Petromantis* and *Neopetromantis*, gen. nov., Rs is only four-branched. In the forewing of *Protochorista* it is five-branched with the extra fork on R_3 or six-branched with the extra forks on R_5 and R_2; in the hindwing the branching is also variable, R_3 being with or without a fork and R_5 sometimes forked. In *Phipoides*, gen. nov., Rs is five-branched with the extra fork on R_2 so that there is a tendency to pectination.

Some of the genera would fall within the Mesochoristidae except for the branching of Sc. Considerable weight has been placed on the development of the cubito-median Y-vein in the separation of some genera as this vein is normally well developed in this family.

Genus **Phipoides**, nov.

Genotype, *Phipoides elegans*, sp. nov.

Forewing.—Costal space expanded, Sc three-branched; Rs five-branched, extra fork on R_2, so that there is a tendency to pectination; M six-branched, the branching similar to that of *Mesochorista*.

Hindwing?: Costal space not expanded; Sc short, simple; R_1 forked near its apex; Rs similar in structure to that of the forewing; M four- or possibly five-branched; Cu and anal veins not well preserved.

The forewing of this genus is close to that of *Protochorista* from the Lower Permian of North America but the forking of Rs is different, tending to be pectinate in *Phipoides* and Sc shows a more dichotomic branching. It differs from *Agetochorista* Martynov in the forking of Rs and in the development of the cubito-median Y-vein.

Phipoides elegans, sp. nov.

(Plate vi, A, fig. 1; Text-fig. 25.)

Forewing.—Wing small, length 8 mm., rather narrow at base, costal space expanded, apex rounded; Sc three-branched, forked twice over its apical half, ending on the costal margin at the junction of the middle and apical thirds of the wing; a transverse cross-vein from the apical branch to R_1; costal space expanded over the basal half of the wing narrowing towards the apex; R_1 simple, or possibly forked in the pterostigma; pterostigma not distinct; Rs arising in the basal third of the wing, stem rather short, five-branched, R_{4+5} forking early, somewhat before R_{2+3}, extra fork on R_2, all branches long; M arising from the base of the wing, six-branched, forking at or after the first forking of Rs, M_{3+4} forking M_{1+2}, extra forks on M_2 and M_4; cubito-median Y-vein reduced, the stem to M being quite reduced, branch from Cu very weak, not as strong as the inter-cubital cross-vein; CuA simple, slightly sinuated near the wing margin, with a distinct cross-vein to the stem of M_4; CuP simple, almost parallel to CuA and connected to it by a cross-vein towards its base; 1A and 2A simple, 3A apparently simple, connected by single cross-veins, 3A short.

Hindwing.—Costal margin not expanded; Sc short, simple, reaching the costal margin a little after the forking of Rs; from near its apex an oblique cross-vein to R_1; pterostigma indistinct; R_1 almost straight, slightly sinuated near its apex where it gives off two short branches to the costal margin; Rs arising very close to the base of the wing, five-branched, R_{4+5} forking early, before R_{2+3}, extra fork on R_2, all branches long; M arising from the base of the wing, fused to CuA for some distance, possibly five-branched, not clearly preserved near the wing margin, first forking at or before the first forking of Rs, M_3 and M_4 simple; CuA straight, strong; CuP and anals indefinite.

Type.—Holotype forewing F.40144 and counterpart F.40117 in the Australian Museum Collection. The description of the hindwing is based on F.40177 which is associated with the forewing on the structure of Rs. It has a structure similar to the hindwing *Parachorista splendida*, but it is only half the size. The length of Sc and the forking of Rs are a little different.

Genus **Neoageta**, nov.

Genotype, *Neoageta elongata*, sp. nov.

Forewing.—Differs from *Agetochorista* in lacking a distinct cubito-median Y-vein. Sc three-branched; Rs five-branched with the extra fork on R_5; M six-branched, extra forks on M_2 and M_4; CuA, CuP simple; 1A, 2A and 3A apparently simple; CuA and M touching.

This cannot be considered an abnormal specimen of *Agetochoristella* described below as, in addition to the six-branched M, there is no distinct cubito-median Y-vein which is normally well developed in genera of this family.

Neoageta elongata, sp. nov.

(Plate vi, A, fig. 6; Text-fig. 26.)

Forewing.—Wing of moderate size, length 12 mm., costal space slightly expanded, apex somewhat pointed, greatest width well beyond the middle; Sc long, extending almost to the pterostigma, forked over its apical half, three-branched, the basal branch short, second branch longer, more oblique but not half apical branch; R_1 simple, very gently curved; pterostigma not clearly defined; Rs arising well towards the base, four-branched, with stem of R_{4+5} very short and all branches very long; M and CuA touching, no cubito-median Y-vein; M six-branched, normal; CuA simple, slight curves near margin; CuP simple, well separated from both CuA and 1A; 1A and 2A simple, 3A apparently so, connected by cross-veins, 3A very short, almost transverse, wing narrowed at base.

Type.—Holotype complete forewing F.43969 in the Australian Museum Collection.

Genus **Neopetromantis**, nov.

Genotype, *Neopetromantis australis*, sp. nov.

Forewing.—Costal space not expanded, Sc forked, three-branched; Rs four-branched; M six-branched, extra forks on M_2 and M_4; CuA and CuP simple; anals probably simple, at least 1A.

The genus differs from *Petromantis* Handlirsch in the type of branching to Sc and in lacking a cubito-median Y-vein.

Neopetromantis australis, sp. nov.

(Plate vi, A, figs. 2–3; Text-fig. 27.)

Forewing.—Wing of moderate size, length of preserved portion 5 mm., costal space not expanded, apex rounded, greatest width well beyond the middle; Sc long, extending almost to the pterostigma, forked over its apical half, three-branched, the two basal branches short, almost transverse, a cross-vein to R_1 after the first forking; R_1 simple, only very gently curved; pterostigma not clearly defined; Rs arising towards the base of the wing, four-branched, the forking of R_{2+3} and R_{4+5} almost in line, both towards the wing margin so that their stems are longer than the stem of Rs; M fused to CuA for

some distance, no cubito-median Y-vein, six-branched, forking well before the first forking of Rs, M_{3+4} forking before M_{1+2}, extra forks on M_2 and M_4; CuA simple, almost straight, CuP simple, well separated from both CuA and 1A; 1A apparently simple, 2A and 3A not preserved.

Type.—Holotype forewing F.40211 in the Australian Museum Collection.

F.40173 and F.41120, though fragmentary, are referred to this species. F.43122, an almost perfect wing, is referred provisionally to this species though it lacks the anterior margin beyond the first forking of Sc. The species is very similar to "*Petrochorista*" *dubia* Martynov but differs in the forking of Sc. Except for the three-branched Sc this species would fall within *Mesochorista*.

Genus **Agetochoristella**, nov.

Genotype, *Agetochoristella adscita*, sp. nov.

Forewing.—Sc three-branched, costal space somewhat expanded; Rs five-branched, dichotomously, extra forking on R_5; M five-branched, extra forking on M_2; cubito-median Y-vein distinct; CuA and CuP simple; 1A and 2A simple.

Hindwing.—Sc short, probably simple; R_1 forked near its apex; Rs five-branched, similar to forewing; M five-branched, extra fork on M_2; cubito-median Y-vein distinct; CuA simple; CuP and 1A fused for part of their length; 2A apparently forked, 3A not preserved.

Although this genus shows a branching of Rs and M similar to that of *Protochorista tetraclada*, it differs markedly in the forking of Sc and R_1 and in the structure of the cubito-median Y-vein, whether *Protochorista tetraclada* be considered a fore- or hindwing. The genus *Protochorista* is better removed from the Permopanorpidae to this family.

Agetochoristella adscita, sp. nov.

(Plate vi, A, figs. 4–5; Text-figs. 28–32.)

Forewing.—Wing of moderate size, length 10 mm., costal space somewhat expanded over most of its length, apex evenly rounded; Sc long, three-branched, the first forking about the middle of its length, branches evenly spaced, first branch more or less transverse, second and third increasingly oblique; an oblique cross-vein from the middle of the apical branch to R_1 and possibly a second cross-vein nearer its apex; R_1 simple, almost straight, passing to the wing margin through the pterostigma; pterostigma well defined, extending below R_1, basal border obliquely truncate; subcostal space not wider at the origin of Rs; Rs arising at the level of the first forking of Sc, five-branched, R_{4+5} forking before R_{2+3} but both forks long, extra forking on R_5 after the forking of R_{2+3}; M arising close to the base, at least not after the level of the humeral cross-vein, five-branched, forking at or before the first forking of Rs, M_{3+4} forking before M_{1+2}, extra fork on M_2; cubito-median Y-vein distinct, the arms slightly unequal, CuA continuing the same line as the M branch to the wing margin; CuP widely separated from CuA, simple, connected by a cross-vein closer to the fork of Cu than to the wing margin; 1A and 2A simple.

Hindwing?.—Wing of moderate size, costal space not expanded, costal margin almost straight, apex a little pointed, greatest width beyond the middle; Sc short, simple or possibly with short transverse branches to the costal margin, from near its apex an oblique cross-vein to R_1; R_1 almost straight, close to Sc, with two short branches to the costal margin from near its apex; pterostigma extending below R_1; Rs arising close to the base, in the first quarter of the wing length, five-branched, first forking on a level with the apex of Sc, R_{4+5} forking before R_{2+3}, extra fork on R_5; M arising from the stem of R close to the wing base, five-branched, forking before the level of the first forking of Rs, M_{3+4} forking just before M_{1+2}, extra fork on M_2; cubito-median Y-vein distinct, M branch considerably shorter than Cu branch; CuA simple, straight; CuP and 1A fused for part of their length, free and diverging over their apical halves; 2A apparently forked, 3A not preserved.

Type.—Holotype forewing F.43656 in the Australian Museum Collection, complete except for the extreme base. An underlying hindwing projects only at the anterior apex and shows branched R_1 and reduced branching of R_{2+3}. The description of the hindwing is based on F.39890 and counterpart with the same number in the Australian Museum but designation of a type hindwing is left till there is more definite association.

There are a number of additional specimens. F.46223 is complete except for the posterior border ; F.40159 is without the extreme base and the anal veins; F.40183 has the anterior third of the wing preserved and this shows the branching of Sc and of Rs. F.40185 is of the posterior half of the wing showing the branching of M and with the anals almost complete. F.43124, which shows the body of an insect with overlapping fragmentary wings, is only doubtfully referred to this species. Two hindwings, F.26975 and F.41018, are only doubtfully referred to this species. They are complete except for the anal fields and have only a four-branched Rs.

Family XENOCHORISTIDAE, nov.

Forewing.—M four-branched; Rs four-branched; Sc three-branched, dichotomously; cubito-median Y-vein distinct, well-developed.

This family is separated largely on the structure of Sc and of the cubito-median Y-vein, which recalls that seen in the Paramecoptera (*Belmontia*). On the structure of the radial and median fields it would fall in the succeeding family, Mesopanorpodidae. It could be derived from the Agetopanorpidae through *Agetochoristella* by reduced branching of M.

Genus **Xenochorista**, nov.

Genotype, *Xenochorista splendida*, sp. nov.

Forewing.—Costal space moderately expanded, Sc forked over its apical half, three-branched; Rs and M four-branched; cubito-median Y-vein well-developed; CuA CuP and anals, with possible exception of 3A, simple.

Xenochorista splendida, sp. nov.

(Plate vi, A, fig. 9; Text-fig. 33.)

Forewing.—Wing rather large, length 11 mm., costal space moderately expanded, apex evenly rounded, greatest width somewhat beyond the middle; Sc long, extending into the pterostigma, forked over its apical half, three-branched, the branches evenly spaced, a cross-vein from the apical branch to R_1; margins of pterostigma not clearly defined; subcostal space widest at the first forking of Sc; R_1 simple, sigmoidally curved, concave at origin of Rs, smaller curves over the apical half; Rs arising in the basal third of the wing, four-branched, R_{4+5} forking before R_{2+3}, a strong cross-vein from the forking of R_{2+3} to R_1; M arising from R at its basal curve, four-branched, forking well before the first forking of Rs, M_{3+4} forking well before the first forking of Rs and also before M_{1+2}; cubito-median Y-vein distinct, arms almost equal, that from M the shorter; CuA simple, a slight sigmoid curve over the apical half; a distinct cross-vein from CuA to M_4 close to its origin; CuP simple; 1A and 2A simple, 3A small, apparently simple.

Type.—Holotype forewing F.40157 in the Australian Museum Collection.

Xenochorista sobrina, sp. nov.

(Plate vi, A, figs. 10–11; Text-fig. 34.)

Forewing.—Wing rather large, length 10 mm., costal space markedly expanded, apex rather pointed, greatest width about the middle; Sc long, forked after the origin of Rs, apparently three-branched, apical branch not clearly preserved; R_1 simple, with a slight sigmoid curvature; pterostigma large, almost touching R_2 below; Rs arising in the basal third of the wing, four-branched, R_{4+5} forking after R_{2+3}, all branches long; M arising close to the base of the wing, four-branched, forking before the first forking of Rs, M_{3+4}

forking well before M_{1+2} and also before the first forking of Rs; cubito-median Y-vein distinct, the branch from M the shorter; CuA simple, straight, except near the wing margin; a distinct cross-vein from CuA to M_4 close to its origin; CuP simple; 1A and 2A simple, 3A apparently simple, connected by cross-veins; cross-veins rather numerous in the radial and median fields.

Type.—Holotype forewing F.43123 in the Australian Museum Collection.

It is possible that this specimen is conspecific with *splendida*, the different structure of Rs being only an individual variation, but as it is abnormal in Mecoptera for R_{2+3} to fork before R_{4+5} the two specimens are treated separately. F.43101 is considered to be the hindwing of this species. It is perfect except for slight distortion at the base and shows a structure of Rs and M identical with that of the forewing. In most features it resembles the hindwing of *Mesochorista*.

Family MESOPANORPODIDAE Tillyard, 1918.

Mesopanorpidae Tillyard, 1917.

Mesopanorpodidae Tillyard, 1918.

Tillyard (1917) described *Mesopanorpa* from Triassic beds of New South Wales, unaware of *Mesopanorpa* Handlirsch 1908 (of the family Orthophlebiidae), but changed the name to *Mesopanorpodes* in 1918.

M four-branched; Rs four-branched; Sc two-branched; cubito-median Y-vein variable.

This family is well represented in the fauna, being next in importance to the Mesochoristidae. It is possible that the species grouped here are not closely related, for the wing structure is reduced almost to its simplest, with both Rs and M four-branched and Sc two-branched. Generic division is based on slight characters, such as the structure of the cubito-median Y-vein area of the wing.

Genus **Mesopanorpodes** Tillyard, 1918.

Genotype, *Mesopanorpa wianamattensis* Tillyard, 1917.

Mesopanorpa Tillyard, 1917 (non Handlirsch, 1908).

Mesopanorpodes Tillyard, 1918.

Forewing.—Sc forked, two-branched; Rs four-branched; R_{2+3} forking before R_{4+5}; M four-branched; cubito-median Y-vein variable; CuA and CuP simple; anal veins simple, although 3A is possibly forked close to its base. The forking of Rs is abnormal and recalls that of Trichoptera.

The costal veinlets recorded for *wianamattensis* are not present in the holotype which is in the Australian Museum, F.39326.

Mesopanorpodes belmontensis, sp. nov.

(Plate vi, A, figs. 12–13; Text-fig. 35.)

Forewing.— Wing of moderate size, length 8 mm., costal space not expanded, apex evenly rounded, greatest width somewhat beyond the middle; Sc long, extending to the pterostigma, forked over its apical third, two-branched, the upper branch almost transverse; a cross-vein to R_1 just before the pterostigma; R_1 simple, sigmoidally curved; pterostigma well defined, extending well below R_1; Rs arising at the junction of the basal and middle thirds of the wing, four-branched, R_{4+5} forking after R_{2+3}, branches rather short; M arising from the base of the wing, taking a very decided bend towards R at the point of contact with CuA, four-branched, forking at or before the first forking of Rs, M_{3+4} forking before M_{1+2}; CuA simple, just touching or slightly fused to M, no distinct cubito-median Y-vein; a cross-vein from CuA to the stem of M_{3+4}; CuP simple, well separated from CuA; 1A and 2A simple, 3A only partly preserved, simple.

Hindwing.—Basal portion not preserved, Sc short, ending on wing margin at level of first forking of Rs, with a distinct curved cross-vein to R_1; R_1 forked near apex, with two short branches to the anterior margin; Rs only three-branched (possibly as an individual variation), R_{4+5} simple; M four-branched, similar over its apical half to the forewing; CuA simple.

Type.—Holotype forewing F.40166 in the Australian Museum Collection. The description of the hindwing is based on F.41237 which shows partly overlapping fore and hindwings.

F.40962 and counterpart F.40961 lacks the anal field. F.43480 shows reduced branching of R_{2+3} as in the forewing of F.41237. F.42499 and counterpart F.42498 shows reduced branching on R_{2+3} and M_{1+2} and may be specifically distinct. The species differs from *wianamattensis* in the much more strongly arched M after its separation from CuA.

The origin of M and the cubito-median Y-vein area recall the structure seen in Recent Bittacidae but in the fossil species there is no narrowing of the base of the wing and all three anal veins are well-developed.

Mesopanorpodes robustus, sp. nov.

(Plate vi, A, fig. 14; Text-fig. 36.)

Forewing.—Wing considerably larger than the other two species, posterolateral areas missing; costal space not expanded; Sc long, extending into the pterostigma, forked over its apical third, two-branched; R_1 simple, sigmoidally curved; Rs arising at the junction of the basal and middle thirds of the wing, four-branched, R_{4+5} forking almost in line with R_{2+3} and not greatly after it; M arising from the base of the wing, taking a very decided bend towards R at the cubito-median Y-vein, which is well-developed with almost equal arms but that from Cu a little longer; M four-branched, forking at about the level of the first forking of Rs, M_{3+4} forking before M_{1+2}; CuA only partly preserved, CuP weak, widely separated from CuA; 1A and 2A simple, 3A forked near its base.

Type.—Holotype forewing F.40787 and counterpart F.40788 in the Australian Museum Collection.

The counterpart shows clearly the anal veins and the basal structures of the wing, but the apical portion is missing.

Genus **Prochoristella**, nov.

Genotype, *Prochoristella megaloprepia*, sp. nov.

Forewing.—Sc long, forked, two-branched; R_1 simple; pterostigma well-developed; Rs four-branched; M four-branched; cubito-median Y-vein variable, from arms equal to CuA just fused to M; CuA and CuP simple; 1A and 2A simple, 3A apparently so.

Hindwing.—Sc short, simple; R_1 forked near apex or possibly simple; pterostigma well-developed; Rs four-branched; M four-branched; CuA fused to M basally; CuP and 1A fused for part of their length.

It has not been possible to associate definitely the hindwings in this genus so they are described separately. The genus is possibly more closely allied to the Nannochoristidae than to the Mesopanorpodidae.

Prochoristella megaloprepia, sp. nov.

(Plate vi, A, figs. 16–17; Text-fig. 37.)

Forewing.—Wing small, length 6·5 to 7·0 mm., costal space not expanded, wing rather narrow, apex evenly rounded; Sc long, forked about the middle of its length, after the origin of Rs, upper branch short, lower branch extending to the pterostigma ; a distinct cross-vein from about the middle of Sc_2 to R_1; humeral cross-vein distinct; subcostal space moderately expanded at the origin of Rs; pterostigma large, clearly

defined, almost touching R_2; R_1 simple, slight sigmoid curvature before the origin of Rs, after that almost straight; Rs arising in the basal third of the wing, four-branched, R_{4+5} forking before R_{2+3}, all branches long; M arising from R before the level of the humeral cross-vein, four-branched, forking at or before the first forking of Rs, M_{3+4} forking before M_{1+2} and also before R_{4+5}, M_{1+2} forking on a level with R_{2+3} or sometimes a little after, depending on the forking of that vein; cubito-median Y-vein somewhat variable, in the holotype with the arms almost equal, in other cases with the branch from M a little reduced; CuA almost straight, a slight curve beyond the cross-vein to M_{3+4}; CuP simple, well separated from both CuA and 1A; 1A and 2A simple, 3A apparently forked close to its base; cross-veins not abundant, ill-defined in most cases.

Type.—Holotype forewing F.40123 in the Australian Museum Collection, a perfect wing.

There are a number of additional specimens. F.40766 is complete but not well-preserved; F.41060 is complete except for the cubital and anal fields. F.40127, F.40214, F.41594, F.41113 and F.40129 are more fragmentary. F.40081 is only doubtfully referred to this species; it shows a well-preserved body but the wings are fragmentary.

Prochoristella anagaura, sp. nov.

(Text-figs. 38–40.)

Forewing.—Wing very small, 5·0 mm., similar to *megaloprepia* but differing typically in the forking of Rs and more particularly in the structure of the cubito-median Y-vein; R_{2+3} normally forking after the forking of M_{1+2}, but branches R_2 and R_3 long; CuA and M touching, no distinct cubito-median Y-vein.

Type.—Holotype forewing F.41319 in the Australian Museum Collection, complete except for the extreme base.

There are a number of additional specimens but most are fragmentary. F.40151; F.40184; F.41184; F.41213 and counterpart F.41214; F.43103 and counterpart F.43102 and F.40966 and counterpart F.40967. F.41254 and counterpart F.41255, doubtfully referred to this species, is of the apical two-thirds of a wing, which has only a three-branched media. In F.41074 and counterpart F.41049 the forking of M_{1+2} is reduced. F.41598 is an almost perfect wing in which R_{2+3} forks before M_{1+2} while in F.41311 they are almost in line.

Some of the specimens placed in this species are separated from *megaloprepia* mainly on shape and size and the structure of the cubito-median Y-vein. The size difference seems to be too great for them to be associated and there is no distinct Y-vein.

Prochoristella exilis, sp. nov.

(Plate vi, A, fig. 18; Text-fig. 41.)

Forewing.—Wing small, 5·5 mm., costal space not expanded, greatest width about the middle, apex evenly rounded; Sc long, forked after the origin of Rs, upper branch short, lower branch almost as long as the stem, extending to the pterostigma; a distinct cross-vein from about the middle of Sc_2 to R_1; R_1 sigmoidally curved, simple; pterostigma well-developed; subcostal space very wide, particularly at origin of Rs; Rs arising in basal third of the wing, four-branched, R_{4+5} forking well before R_{2+3}, stem of R_{2+3} as long as branches R_2 and R_3; M arising from the base of the wing, forking before the first forking of Rs, M_{3+4} forking almost immediately, nearly on a level with the first forking of Rs, M_{1+2} forking after R_{4+5}; cubito-median Y-vein with the branch from M reduced; CuA straight over its middle portion, a distinct curve after the cross-vein to M_4 or M_{3+4}; CuP simple, weak; 1A and 2A simple, 3A apparently simple.

Type.—Holotype forewing F.40168 in the Australian Museum Collection, perfect except for the extreme base.

F.39907 and counterpart with the same number lacks the anals and costal margin and F.40142 and counterpart F.40146 is slightly buckled and lacks the anals.

This species differs from *anagaura* in the forking of M, particularly M_{3+4}, the curved CuA and more strongly curved R. The forking of Rs is also slightly different. Both species show R_3 as well as R_2 curving up at the wing margin. This contrasts with *megaloprepia*.

Prochoristella pusilla, sp. nov.

(Plate vi, A, fig. 19; Text-fig. 42.)

Forewing.—Wing very small, 4·5 mm., costal margin not preserved, apex rounded; Sc not fully preserved; R_1 simple, almost straight, a distinct sigmoid curvature at base; pterostigma large, well-defined, almost touching R_2; Rs arising from towards the base of the wing, four-branched, R_{4+5} forking before R_{2+3}, R_{2+3} forking on a level with the pterostigma; M arising close to the base, four-branched, forking before the first forking of Rs, M_{3+4} forking before M_{1+2}, M_{1+2} forking before R_{4+5}; CuA simple, fused to M for a short distance, no distinct cubito-median Y-vein; CuP simple, weak; 1A and 2A simple, 3A apparently so.

Type.—Holotype forewing F.40061 and counterpart F.40190 in the Australian Museum Collection. There are three additional specimens, F.41091, F.40045 and F.40113 which preserve the radial and median fields.

This species is characterized by the branching of Rs and M, each succeeding branch forking before the one preceding it. It approaches the Protodiptera in the basal structure of R, but has three distinct anal veins.

Prochoristella belli (Tillyard), 1926.

(Plate vi, A, figs. 20–21; Text-figs. 43–44.)

Permochorista belli Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 272.

Hindwing.—Wing rather broad, apex rounded; Sc short, ending on the costal margin close to the level of the first forking of Rs, a cross-vein from near its apex to R_1; R_1 forked near its apex, both branches passing through the pterostigma; pterostigma well-developed, extending only a short distance below R_1; Rs arising close to the base of the wing, four-branched, R_{4+5} forking before R_{2+3} but at the level of the pterostigma, branches R_2 and R_3 short; M four-branched, M_{3+4} forking before M_{1+2} which branches slightly after R_{4+5}; CuA simple; CuP and anals not clearly preserved.

Type.—Holotype hindwing F.19795 in the Australian Museum Collection.

F.41376 shows the origin of Rs while F.39873 shows CuA and some of the anal veins. F.41229 and counterpart F.41228 and F.40187 are referred to this species only doubtfully.

Prochoristella concinna, sp. nov.

(Plate vi, A, fig. 22; Text-fig. 45.)

Hindwing.—Wing small, length 5·0 mm., costal space not expanded, apex rounded, greatest width beyond the middle; Sc short, ending on costal margin at a level before the first forking of Rs, a cross-vein from near its apex to R_1; R_1 almost straight, rather close to the costal margin, possibly simple; pterostigma well-developed; subcostal space narrow; Rs arising close to the base, four-branched, stem long, R_{4+5} forking well before R_{2+3}, well before the level of the pterostigma; M four-branched, forking before the level of the first forking of Rs, M_{3+4} forking before M_{1+2}, and before R_{4+5}; CuA fused to M basally, no cubito-median Y-vein; CuP weak, fused to 1A for part of its length, 1A simple, free at wing margin, 2A and 3A not clearly preserved, both very short.

Type.—Holotype hindwing F.40182 in Australian Museum Collection. There are no additional specimens.

This species differs from *belli* in the forking of R_{4+5}. It is most probably the hindwing of *anagaura*.

Family NANNOCHORISTIDAE Tillyard.

The family is characterized by the reduced branching of Rs (R_{2+3} being simple) and marked fusion of M and CuA near their bases; Sc varies in structure.

The two Recent genera, *Nannochorista* and *Choristella*, differ in the number of cross-veins, there being fewer in *Choristella*.

Two new genera are described from these beds. *Neochoristella* has Rs three-branched and M four-branched as in the Recent genera but *Nannochoristella* has both Rs and M only three-branched. In both the fossil genera Sc is very long and there is only slight fusion between M and CuA.

Genus **Neochoristella**, nov.

Genotype, *Neochoristella optata*, sp. nov.

Forewing.—Sc long, probably forked; R_1 simple; Rs three-branched; M four-branched; cubito-median Y-vein absent, CuA and M fused for some distance; CuA and CuP simple; 1A and 2A simple, 3A apparently so.

This genus differs from *Choristella* in having a longer Sc and less fusion between CuA and M. The long Sc is somewhat similar to that of *Nannochorista holostigma* Tillyard.

Neochoristella optata, sp. nov.

(Text-fig. 46.)

Forewing.—Wing very small, length 4·0 mm., narrow, costal space not expanded, apex rounded, greatest width beyond the middle; Sc long, apparently forked about its middle, reaching the costal margin close to R_1; no distinct pterostigma, subcostal space narrow; R_1 simple, with slight bends; Rs arising about one-third the wing length from the base, three-branched, R_{4+5} forking early, R_{2+3} simple, at least almost to the wing margin which is broken. M arising close to the base, four-branched, forking at or before the level of the first forking of Rs, M_{3+4} forking well before M_{1+2}, which forks well after the forking of R_{4+5}; CuA fused to M for a distance, almost straight, with a slight bend after the cross-vein to M_{3+4}; CuP simple, weak, well-separated from both CuA and 1A; 1A and 2A simple, 3A apparently so.

Type.—Holotype forewing F.41608 in Australian Museum Collection.

This small narrow wing differs in the branching of both Rs and M and in the length of Sc from *Prochoristella*, gen. nov., so that it cannot be considered an abnormal specimen of that genus.

Genus **Nannochoristella**, nov.

Genotype, *Nannochoristella reducta*, sp. nov.

Forewing.—Similar to *Nannochorista* but with a reduced branching of M. Both Rs and M only three-branched; no cubito-median Y-vein but M and CuA fused for a short distance; Sc forked.

Hindwing.—Wing with apex a little more rounded; branching of Rs and M as in forewing; Cu and anals not preserved.

The genus differs from *Nannochorista holostigma*, as far as can be ascertained from the preserved specimen, only in the three-branched M, less fusion between M and CuA and more basad origin of M.

Nannochoristella reducta, sp. nov.

(Text-fig. 47.)

Forewing.—Length 5 mm., apex somewhat sharply rounded; Sc long, forked about its middle, ending on the costal margin, with a transverse cross-vein to R_1 from towards its apex; R_1 simple, slightly curved near its apex; Rs arising before the middle of the

wing, R_{2+3} simple; first forking of M obscured, M_{3+4} simple; M and CuA fused for a short distance; CuA simple, slightly curved at the wing margin; CuP and anal veins simple, 3A apparently so.

Hindwing.—Imperfect, only apical third preserved; R_1 straight at apex, with a transverse branch to the costal margin; Rs and M both three-branched as in the forewing; CuA simple at apex; CuP and anals not preserved.

Type.—Holotype F.39968 in the Australian Museum Collection preserves portions of all four wings and the body. The wings of the left side almost completely overlap and those on the right side are separated, but only the posterior margin of the forewing is preserved. The abdomen is exposed over the missing basal portion of the hindwing.

There are no additional specimens. It is possible that this is only a variant of *Neochoristella* with only a three-branched M, but as it shows such marked reduction in the branching of Rs and M it has been considered distinct.

Suborder PROTODIPTERA.

Differing from true Diptera in possessing four wings and in the base of the wing not being distinctly petiolate.

Rs three- or four-branched; M four-branched; anals reduced, two or rarely three.

Tillyard (1937) figures an almost complete specimen of a Protodipteron in *Nature* (p. 66), but does not give a name or specific description. The location of this specimen is not known. It is not in the Australian Museum Collection.

Martynova (1948) has erected a new species and genus, "*Robinjohnia tillyardi*", without seeing the specimen or knowing of its location.

Family PERMOTANYDERIDAE, nov.

Genus **Permotanyderus**, nov.

Genotype, *Permotanyderus ableptus*, sp. nov.

Forewing.—Sc long and simple, close to the costal margin; pterostigma well-developed; Rs four-branched; M four-branched; CuA simple, bent over its apical portion; CuP weak; anals two.

Permotanyderus ableptus, sp. nov.

(Plate vi, A, fig. 23; Text-fig. 48.)

Forewing.—Wing very small, length 5·0 mm., long and narrow, costal margin almost straight, apex rather pointed, posterior border rounded, tapering slightly to base, greatest width well beyond the middle; Sc simple, long, lying close to the costal margin, ending on the costal margin in the pterostigma; humeral cross-vein near base, distinct; a transverse cross-vein from R_1 soon after its origin to Sc; R_1 distinctly kinked close to its base, straight for most of its length, simple; pterostigma well-developed, extending well below R_1; Rs arising at junction of basal and middle thirds of the wing, four-branched, R_{4+5} forking soon after its origin, well before R_{2+3} which forks at or after the level of the pterostigma; M arising from close to the base, at the bend of R, four-branched, forking at or after the forking of Rs, with M_{3+4} forking a little before M_{1+2}, M weak after the cubito-median Y-vein; cubito-median Y-vein distinct, arms about equal; CuA simple, a distinct bend at the cross-vein to M_{3+4}; CuP simple, weak, connected to CuA by a cross-vein close to the cubito-median Y-vein; 1A simple, long, sigmoidally curved, 2A much shorter, almost straight, only two anal veins; R_1, CuA and the basal stem of M are more strongly developed than the other veins and the stem of M and CuP are the weakest.

Type.—Holotype wing F.40675 in the Australian Museum Collection.

There are three additional specimens. F.40140 and counterpart F.40203 shows a pair of superimposed wings complete except for the extreme base including part of the anal veins. It shows the first anal and what is either the second anal or the wing margin. F.41326 and counterpart F.41327 is complete except for some of the branches of the media and Rs. It shows clearly the anal area with two anal veins and not particularly narrowed wing base. F.41369 is more fragmentary.

Genus **Choristotanyderus**, nov.

Genotype, *Choristotanyderus nanus*, sp. nov.

Hindwing?.—Sc long, close to the costal margin; pterostigma well-developed, well before the apex of the wing; Rs arising at the basal third of the wing, four-branched; M four-branched; cubito-median Y-vein present; CuA with a slight bend towards its apex; only two anal veins.

It is quite possible that this is the hindwing of *Permotanyderus*, for the wings differ only in shape and the position of the pterostigma. Both have only two small anal veins.

Choristotanyderus nanus, sp. nov.

(Text-fig. 49.)

Hindwing?.—Wing very small, length 4·0 mm., triangular, costal space not expanded, apex rather pointed, greatest width beyond the middle, base rather narrowed; Sc apparently simple, long, extending into the pterostigma; R_1 almost straight, simple; pterostigma large, well defined, situated well before the apex of the wing; Rs arising in the basal third of the wing but near the middle of R_1, four-branched, R_{4+5} forking early, well before R_{2+3}; M arising close to the base, well separated from Rs, four-branched, forking after the first forking of Rs, M_{3+4} forking before M_{1+2}, on a level with R_{4+5}; CuA simple, a distinct bend towards the apex where it sends a cross-vein to M_{3+4}; CuP simple, closer to CuA than to 1A; 1A simple, with a slight sigmoid curvature, long, 2A well separated, much shorter; apparently only two anals.

Type.—Holotype wing F.39964 in the Australian Museum Collection.

The abdomen preserved with the type shows clearly the terminalia. The holotype was a male with terminalia of the mecopteroid pattern.

Family PERMOTIPULIDAE.

Genus **Permotipula** Tillyard, 1929.

Genotype, *Permotipula patricia* Tillyard, 1929.

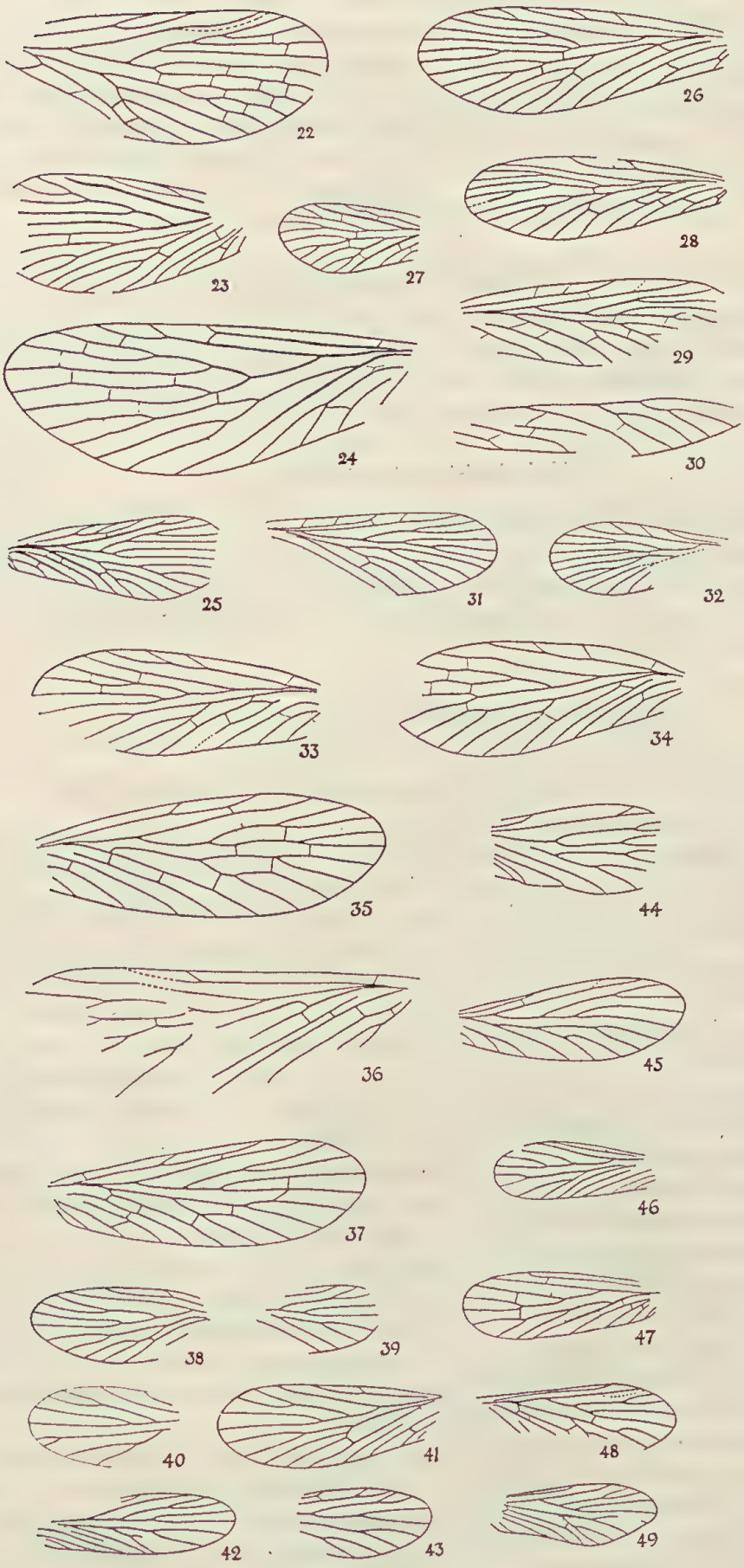
Sc rather short, reaching only to the middle of the wing; pterostigma well-developed; Rs three-branched, R_{2+3} simple; M four-branched, arising close to the base; cubito-median Y-vein still distinguishable, arculus not distinctly formed; CuP reduced; only two anal veins.

Permotipula patricia Tillyard, 1929.

Permotipula patricia Tillyard, 1929, Nature, cxxiii, 779.

Tillyard gives a figure of this species from which the specific characters can be ascertained.

Type.—It was not stated where the holotype was deposited. It is not in the Australian Museum Collection.



Text-figures 22–49.

Figures 22–34 x 3 ca.; 35–49 x 5 ca.

22, F.38272, holotype of *Parachorista pincombeae* Tillyard.—23, F.28049, *Parachorista pincombeae* (holotype of *P. warnerensis* Tillyard).—24, F.28048, holotype of *Parachorista splendida* Tillyard.—25, F.40144, holotype of *Phipoides elegans*, sp. nov.—26, F.43969, holotype of *Neocgeta elongata*, sp. nov.—27, F.40211, holotype of *Neopetromantis australis*, sp. nov.—28, F.43656, holotype of *Agetochoristella adscita*, sp. nov.—29, F.46223, forewing of *Agetochoristella adscita*.—30, F.40185, forewing of *Agetochorista adscita*. Posterior portion showing anals.—31, F.39890, hindwing of *Agetochorista adscita*.—32, F.26975, hindwing of *Agetochorista adscita*, with a four-branched Rs.—33, F.40157, holotype of *Xenochorista splendida*, sp. nov.—34, F.43123, holotype of *Xenochorista sobrina*, sp. nov.—35, F.40166, holotype of *Mesopanorpodes belmontensis* Tillyard.—36, F.40787, holotype of *Mesopanorpodes robustus*, sp. nov.—37, F.40123, holotype of *Prochoristella megaloprepia*, sp. nov.—38, F.41319, holotype of *P. anagaura*, sp. nov.—39, F.41254, *P. anagaura*?.—40, F.41074, *P. anagaura*.—41, F.40168, holotype of *P. exilis*, sp. nov.—42, F.40061, holotype of *P. pusilla*, sp. nov.—43, F.19795, holotype of *P. belli* (Tillyard).—44, F.39873, *P. belli*.—45, F.40182, holotype of *P. concinna*, sp. nov.—46, F.41608, holotype of *Neochoristella optata*, sp. nov.—47, F.39968, holotype of *Nannochoristella reducta*, sp. nov.—48 F.40675 holotype of *Permotanyderus ableptus*, sp. nov.—49, F.39964, holotype of *Choristotanyderus nanus*, sp. nov.

Order TRICHOPTERA.

This order has not been recognized previously from the Australian Upper Permian fauna. The true position of the single species, *Cladochorista belmontensis* Tillyard, 1926, was not recognized from the fragmentary type. Additional specimens have elucidated the complete wing structure, which differs from that of living species (except *Perissoneura*), mainly in the strong development of the costal veinlets. Prior to this Permian record the oldest undoubted Trichoptera were the small types of the family Necrotauliidae, found in the Rhaetic, Lower and Upper Lias of England and Germany.

Family CLADOCHORISTIDAE, nov.

Costal space expanded over the basal half; Sc connected to R_1 by an oblique cross-vein, R_1 branched beyond this point; pterostigma only weakly developed; Rs four-branched; M four-branched; CuA with a well-developed fork; CuP simple; 1A simple, 2A and 3A looped on to the preceding vein.

Genus **Cladochorista** Tillyard, 1926.

Genotype, *Cladochorista belmontensis* Tillyard, 1926.

Costal space with numerous oblique cross-veins; R_1 branched at apex; R_{2+3} branching before R_{4+5}; a distinct cross-vein between Sc and R before the origin of Rs; M four-branched; cubito-median Y-vein distinct; CuA branched at or beyond its middle; CuP simple, weak; anal veins looped.

Cladochorista belmontensis Tillyard, 1926.

(Plate vi, A, figs. 7–8; Text-figs. 50–52.)

Cladochorista belmontensis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 273.

Forewing.—Wing of moderate size, apex rounded; costal space with a series of from six to nine simple, oblique veinlets; Sc long, ending on the anterior margin; R_1 straight, forking beyond the apex of Sc, with two or three branches; no distinct pterostigma preserved; a basal cross-vein before the origin of Rs connects R and Sc; Rs arising towards the base of the wing, four-branched, stems of R_{2+3} and R_{4+5} both short, with that of R_{2+3} the shorter so that R_{2+3} branches before R_{4+5}; M four-branched, the forking of M_{1+2} after that of M_{3+4} and also after that of R_{4+5}; cubito-median Y-vein well-formed, the arms almost equal; CuA forked over its apical third or so, the forking before the forking of M_{3+4}; CuP parallel to CuA, rather widely separated from it, weak; 1A simple, straight, parallel to CuP, 2A shorter, looped on to 1A, 3A quite small, looped on to 2A; 2A and 3A lie well away from the wing margin.

Type.—Holotype forewing specimen F.28054 in the Australian Museum Collection (No. 96 of Mitchell's Collection). The counterpart of the type (F.28962), which is more complete basally, was not mentioned in the original description.

There are ten additional specimens referred to this species. F.43133 and counterpart F.43134 are two almost complete over-lapping wings; F.41374 and F.41372 show the looping of the anal veins; F.40155 and counterpart F.40035, F.41008, F.40220 and F.42482 show the forked CuA, while the remaining specimens, F.40219, F.40118, F.40147 and counterpart F.40120, though more fragmentary, show the characteristic branching of R_{4+5} and the development of the costal veinlets.

A re-examination of the fragmentary type shows how Tillyard was misled in his interpretation of the venation, particularly in the median and cubital fields. The more basad cross-veins of the costal space are poorly preserved and so were easily overlooked. The portion of the wing in the region of the cubito-median Y-vein is not preserved so that CuA has been regarded as the posterior branch of M and CuP is labelled Cu_1 (CuA). M_1 of Tillyard forks just at the edge of the preserved portion of the fossil and is really M_{1+2}

dividing into M_1 and M_2; M_2 is M_3 and M_{3a} is M_4 which arises as a branch of M_3 and is connected to CuA_1 by a cross-vein. The M_{3b} and M_4 of Tillyard are the two branches of the forked CuA.

In *Permomerope*, both forking of CuA and looping of the anal veins occur, but that genus, on the structure of Sc and R_1 and with much-branched veins, is best considered a Mecopteron (suborder Protomecoptera).

Order NEUROPTERA (PLANIPENNIA).

The species of Neuroptera described from these beds have been placed in four genera, all in the family Permithonidae. With the examination of many additional specimens one of these is considered a synonym. There are some quite marked differences between these genera so that it seems advisable to separate one of the three. *Permorapisma* is allied to *Permithone* (syn. *Permosmylus*) and is retained in the Permithonidae. *Permopsychops* is quite different and is placed in a separate family, differing from the Permithonidae in the limited number of cross-veins between R_1 and Rs, limited end-twigging to the numerous pectinate branches of Rs and in the distinctive anal field. Two new genera are described in this paper. One is placed in a new family related to the Recent Osmylidae and the second belongs to the family Permoberothidae. The discovery of a representative of this last family, which previously was known only from the Lower Permian of Kansas, is perhaps the most interesting find of all, though it is only doubtfully considered to be a Neuropteron.

Key to Families and Genera.

1. Wing almost entirely divided into cellules; a distinct groove between MA and MP; no pterostigma..... Family Permoberothidae.....Genus *Permoberothella* nov.

— Wing not divided into cellules, cross-veins variable; no marked groove between MA and MP; a distinct pterostigma... 2

2. Rs with numerous, pectinate branches (10 or more); only three strong cross-veins between R_1 and Rs and limited to apical half; 1A with a simple fork near apex; CuP simple; end-twigging of Rs limited..... Family Permopsychopsidae.....Genus *Permopsychops* Tillyard.

— Rs with limited branches; cross-veins from R_1 to Rs generally four or more, evenly spaced over the distance; 1A pectinately branched near apex, CuP simple or with small terminal twigging.....Family Permithonidae.

(i) Intercubital space reticulate,.....Genus *Permorapisma* Tillyard.

(ii) Intercubital space with simple cross-veins.....Genus *Permithone* Tillyard.

— Rs with ten or so branches; cross-veins from R_1 to Rs reduced (obscured); 1A pectinately branched near apex; CuP deeply forked..... Family Archeosmylidae.....Genus *Archeosmylus*, nov

Family PERMOBEROTHIDAE.

Wings subequal.

Forewing.—Costal area broader than in hindwing; Sc terminating on the costal margin, a series of costal veinlets connecting it to the anterior margin; pterostigma absent; Rs arising from R near the base of the wing; MA coalesced with Rs for a short distance proximally, then continuing as a nearly straight vein almost to the very apex of the wing; MP coalesced proximally with CuA for a short distance, then continuing close to MA and parallel to it; between MA and MP there is a distinct groove, as in Recent Hemerobiidae and other families of Neuroptera; Cu forking at base into CuA and CuP, CuA coalesced with MP for a short distance, simple; CuP is a faint but distinct straight vein.

Hindwing.—Sc close to R and terminating on R_1 not far from mid-wing; Rs arising from R as in forewing and coalesced with MA for a greater interval than in the forewing; Rs forked as in the forewing; MA, MP, CuA and CuP essentially as in the forewing; groove present between MA and MP.

The family is represented by one genus in the Lower Permian of Kansas and a new genus from the Upper Permian of New South Wales. The new genus differs primarily in the branching of MP (CuA_1), more complete cross-veins and complex cross-veins of the anal field.

Genus **Permoberothella**, nov.

Genotype, *Permoberothella perplexa*, sp. nov.

Forewing.—Costal margin not preserved, Sc only partly preserved; R, Rs and MA as in *Permoberotha*; between MA and MP a distinct groove; MP two-branched with terminal twigging; CuA and CuP simple; three simple anal veins connected by irregular cross-veins.

Permoberothella perplexa, sp. nov.

(Plate vi, A, fig. 24; Text-fig. 53.)

Forewing.—Length 7 mm., width of preserved portion 2 mm., anterior margin not preserved; only median portion of Sc preserved; R with a slight downward bend near the base just after the origin of Rs and there with a short oblique cross-vein to Sc; R_1 simple, continued around the margin of the wing almost to the apex; MA arising from R very close to the base and there strongly deflected away from it, continuing almost straight, as a simple vein, to the wing margin just below the apex; Rs arising as a triad very close to MA, zig-zagged, forking well before the middle of the wing, the two branches uniting just before the wing margin; MP arising from CuA between the origin of MA and of Rs from R, forking just before the forking of Rs, then each of these two branches forking almost at the wing margin; CuP simple, close to CuA; CuA forked at wing margin; three simple anal veins; cross-veins very numerous, there being more than one hundred in the preserved portion of the holotype, simple except between 2A and 3A and possibly between 1A and 2A. A distinct groove between MA and MP and a single cross-vein towards the wing margin. The forking of Cu is not preserved and the anal field is torn at the base. Macrotrichia are discernible on most of the veins and cross-veins.

Type.—Holotype forewing F.42520 in the Australian Museum Collection.

Additional Specimens.—F.40270 preserves the radial field and shows macrotrichia clearly. F.40657 preserves the apical half of the anterior margin to as far as MA. In this specimen Rs is three-branched, with the extra fork occurring on R_{2+3} soon after its origin. The two branches, R_2 and R_3, unite before the wing margin and the united vein unites with R_{4+5} also just before the wing margin. The reunion of the branches of Rs would seem to be a specific character and not an individual variation.

The species differs markedly from the other Neuroptera of these beds and there does not seem to be any close affinity with them.

Family PERMITHONIDAE.

Forewing.—Costal veinlets simple or more often somewhat branched and connected by irregular cross-veins; Sc fused with R_1 distally; numerous cross-veins between R and Rs; Rs pectinately branched but branches few in number; a distinct cubito-median Y-vein; CuP simple or with only small terminal twigging; anal veins well-branched, with irregular cells between 2A and 3A and sometimes between 1A and 2A.

Hindwing.—Imperfectly known, costal space not as wide as in forewing, costal veinlets simple.

The Permithonidae seem to have evolved from a Permosisyrid-like form by increased end-twigging, extra forking of Rs and by the fusion at the apex of Sc and R_1. In the Permosisyridae, however, there is the advanced feature of a strongly forked CuP which is absent in the Permithonidae.

The Sialidopsidae of Zalessky is considered to fall within the Permithonidae though Sc and 1A are a little different but only of generic significance.

The family seems to be ancestral to both the Berothidae and the Osmylidae. The Berothidae can be derived from a form such as *Permithone* by more complete forking of the costal veinlets in the forewing, deep forking of CuP and a general reduction in the cross-veins both between R_1 and Rs and in the gradate series which are still irregular

in *Permithone*, The Osmylidae, more especially the Protosmylinae (*Gryposmylus*), can be derived from *Permithone* by increased pectination of Rs, CuA and CuP and the arrangement of gradate series of cross-veins and also the prolongation of the pterostigma round the curved anterior border towards the apex.

An early Osmylid type is described later in this paper but so far a Berothid-like form has not been recognized in these Permian beds.

Genus **Permithone** Tillyard, 1922.

Genotype, *Permithone belmontensis* Tillyard, 1922.

Permithone Tillyard, 1922, 1926.

Permosmylus Tillyard, 1926.

Forewing.—Sc fused to R_1 distally; costal space expanded at base; costal veinlets near base usually branched and connected by a few irregular cross-veins or else all simple; numerous (6–7) cross-veins from R to Rs; Rs with only a few pectinate branches (4–5 not including MA); MP forking towards the base of the wing, before the forking of " Rs "; a distinct cubito-median Y-vein; CuA branched, generally pectinately; CuP simple or at most with a short fork near apex; 1A pectinately branched; 2A and 3A branched, enclosing an irregularly-celled area; cross-veins between CuA and CuP simple or irregular.

Hindwing.—Costal space narrow, costal veinlets normally simple and without cross-veins; CuA pectinately branched; CuP simple; M forks at or before the first forking of Rs; CuA touching or fused to M for a short distance, no cubito-median Y-vein.

Permithone differs from *Palaemerobius* mainly in the structure of the anal veins, fusion of Sc with R_1 and in having a distinct cubito-median Y-vein.

Permithone belmontensis Tillyard, 1922.

(Plate vi, B, figs. 1–3; Text-figs. 54–55.)

Permithone belmontensis Tillyard, 1922, Proc. Linn. Soc. N.S.W., xlvii, 290; Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 278.

Permosmylus pincombeae Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 281.

Forewing.—Length of wing 9–11 mm.; costal space strongly expanded over its basal half; costal veinlets sometimes branched and connected by a few irregular cross-veins over the basal half; Sc fused to R_1, which shows little if any deflection in the pterostigmatic region; numerous cross-veins, six or seven, between R and Rs; Rs (including MA) arising close to the base of the wing, with only a few pectinate branches, five or six, each branch forking again not before its middle and with limited end-twigging to the branches; MP dichotomously branched, the first forking before the first forking of Rs, M_{3+4} forking a little before M_{1+2} and each of these branches forking at least once more before the wing margin; a distinct cubito-median Y-vein, the arms unequal; CuA branched at its apex, generally pectinately; CuP simple or with a short terminal twigging; 1A pectinately branched, 2A and 3A branched, enclosing an irregularly-celled area; cross-veins mostly simple except those between 2A and 3A and in some cases, including the type, between CuA and CuP.

Type.—Holotype F.28465 in the Australian Museum Collection. (Specimen No. 52 of Mitchell's Collection.)

The holotype of *pincombeae*, F.19794, is also in the Australian Museum Collection. There is a poorly preserved specimen (No. 97 of Mitchell's Collection), determined by Tillyard, in the Cawthron Institute Collection. There are two additional specimens referred to this species. F.40272 and counterpart F.40156 is a complete wing showing clearly the structure of the anal field. F.40268 is also a complete wing but it differs in some respects from the type in having all the costal veinlets simple and CuA four-branched, dichotomously.

Permithone oliarcoides Tillyard, 1926.
(Plate vi, B, figs. 8–9; Text-figs. 56–57.)

Permithone oliarcoides Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 278.

Hindwing.—Length of wing 10 mm.; costal space not markedly expanded; costal veinlets simple; Sc fused to R_1 which is slightly deflected around the pterostigma; numerous cross-veins between R and Rs; Rs (including MA) arising close to the base of the wing, with only a few (five) pectinate branches; M forking before the first forking of Rs, M branching dichotomously; CuA pectinately branched over its apical third, with at least three branches; CuP only partly preserved, connected to CuA by simple cross-veins. In a second wing M_{3+4} touches or fuses with CuA towards its apex, so that there is some doubt as to the actual branching of these two veins, CuA may have three branches, the other three branches may be those of M_{3+4}. Stem of MA from M to the stem of Rs near its origin, very oblique.

Type.—Holotype F.28052 and counterpart F.28024 in the Australian Museum Collection. Tillyard does not mention the counterpart in his original description.

There are only two additional specimens referred to this species. F.40265 is a wing, folded longitudinally on itself; F.40269 is complete except for the anal field and extreme base and there is some distortion towards the base. It preserves clearly the free base of MA.

This species very probably represents the hindwing of *Permithone belmontensis*, known only from the forewing, but, until the two can be associated, the species will be kept distinct. The branching of Rs and the position and direction of the cross-veins between R and Rs are similar in the two. In *oliarcoides* the costal space is narrower and the pterostigma shorter.

Permithone neoxenus, sp. nov.
(Plate vi, B, fig. 4; Text-fig. 58.)

Forewing.—Length of wing 11 mm.; costal space only slightly expanded over its basal half; costal veinlets occasionally branched over the basal half; Sc probably fused to R_1, obscured; cross-veins between R and Rs more than three; Rs (including MA) arising close to the base of the wing, with six pectinate branches, each branch forking again not before its middle, except for the third branch, and all branches with limited end-twigging; M dichotomously branched, the first forking before the first forking of Rs, partly obscured in the type, M_{3+4} forking a little before M_{1+2} and all of the branches forking at least once before the wing margin; a small, distinct cubito-median Y-vein, the arms about equal; CuA pectinately branched at its apex, CuP simple; 1A and 2A pectinately branched, 3A not preserved. The one preserved cross-vein from CuA to CuP simple.

Type.—Holotype F.40271 in the Australian Museum Collection.

This species, described from a single specimen, differs from *belmontensis* in the shape of the cubito-median Y-vein, the more basad origin of Rs, almost in line with the cubito-median Y-vein and more pronounced end-twigging of all veins including CuP. The cross-veins between R_1 and Rs are reduced.

Genus **Permorapisma** Tillyard, 1926.

Genotype, *Permorapisma biserialis* Tillyard, 1926.

Forewing.—Costal space enlarged near base; Sc fused to R_1 distally. Costal veinlets often branched and connected by numerous irregular cross-veins. R and Rs connected by numerous (ten or more) cross-veins. Rs including MA with numerous (nine) pectinate branches, end-twigging dense. M forking at or after the forking of Rs. A distinct cubito-median Y-vein (the branch from M reduced). CuA branched towards apex. CuP simple or with a short fork at apex. 1A, 2A and 3A pectinately branched. Cross-veins from CuA to CuP not simple, reticulate, forming two or three cells between the two veins. Similar reticulate cross-veins between 1A and 2A and between 2A and 3A.

Permorapisma biserialis Tillyard, 1926.

(Plate vi, B, figs. 5–6; Text-figs. 59–63.)

Permorapisma biserialis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 279.

Permorapisma triserialis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 279.

Forewing.—Length of wing 19–20 mm.; costal space expanding rapidly from the base and then decreasing again towards the pterostigma. Costal veinlets often branched and connected by numerous irregular cross-veins. Sc fused with R_1 at the pterostigma which is short and broad, R_1 curved around it slightly. Ten or more cross-veins between R and Rs. Rs arising close to the base of the wing, with eight or nine pectinate branches, each branch forking at about its middle or a little more distad, with further branches closer to the wing margin. M dichotomously branched, M_{3+4} forking well before M_{1+2} and with a greater number of terminal branches. A distinct cubito-median Y-vein, arms unequal. CuA branched dichotomously over its apical third, CuP simple or with a fine end-twigging. Anal veins all pectinately branched. Intercubital cross-veins reticulate, varying from a biserial to a triserial condition. Cross-veins between 1A and 2A and between 2A and 3A reticulate, but irregularly so.

Type.—Holotype forewing F.28053 and counterpart F.29034 in the Australian Museum Collection (Specimens No. 95 and 95*a* of Mitchell's Collection).

The type of *triserialis* (F.28051 and counterpart F.28959) is also in the Australian Museum Collection (No. 86 and 86*a* of Mitchell's Collection).

There are a number of additional specimens of this species. F.40266 and counterpart F.40267 is an almost complete forewing, somewhat larger than the holotype, showing the transition from a biserial to a triserial condition of the intercubital cross-veins. The anal field is very clearly preserved. F.43076 and counterpart, in two pieces, F.43075 and F.43077, F.41088, F.42465, F.40274, F.41340 and F.41738 are more fragmentary. Somewhat doubtfully referred to this species are specimens F.41362, F.40775 and counterpart F.40774 and F.41005.

The biserial condition of the intercubital cross-veins appears to be more normal and no other specimen with the triserial arrangement as well-developed as the type of *triserialis* has been found. There are two specimens which show an intermediate condition, F.40266 and F.43076.

The hindwing of this species has not been recognized.

Permorapisma differs from *Permithone* only in slight characters. M forks after the first forking of Rs, the costal veinlets are more irregular and the veinlets between CuA and CuP either biserial or triserial in *Permorapisma*.

Family PERMOPSYCHOPSIDAE, nov.

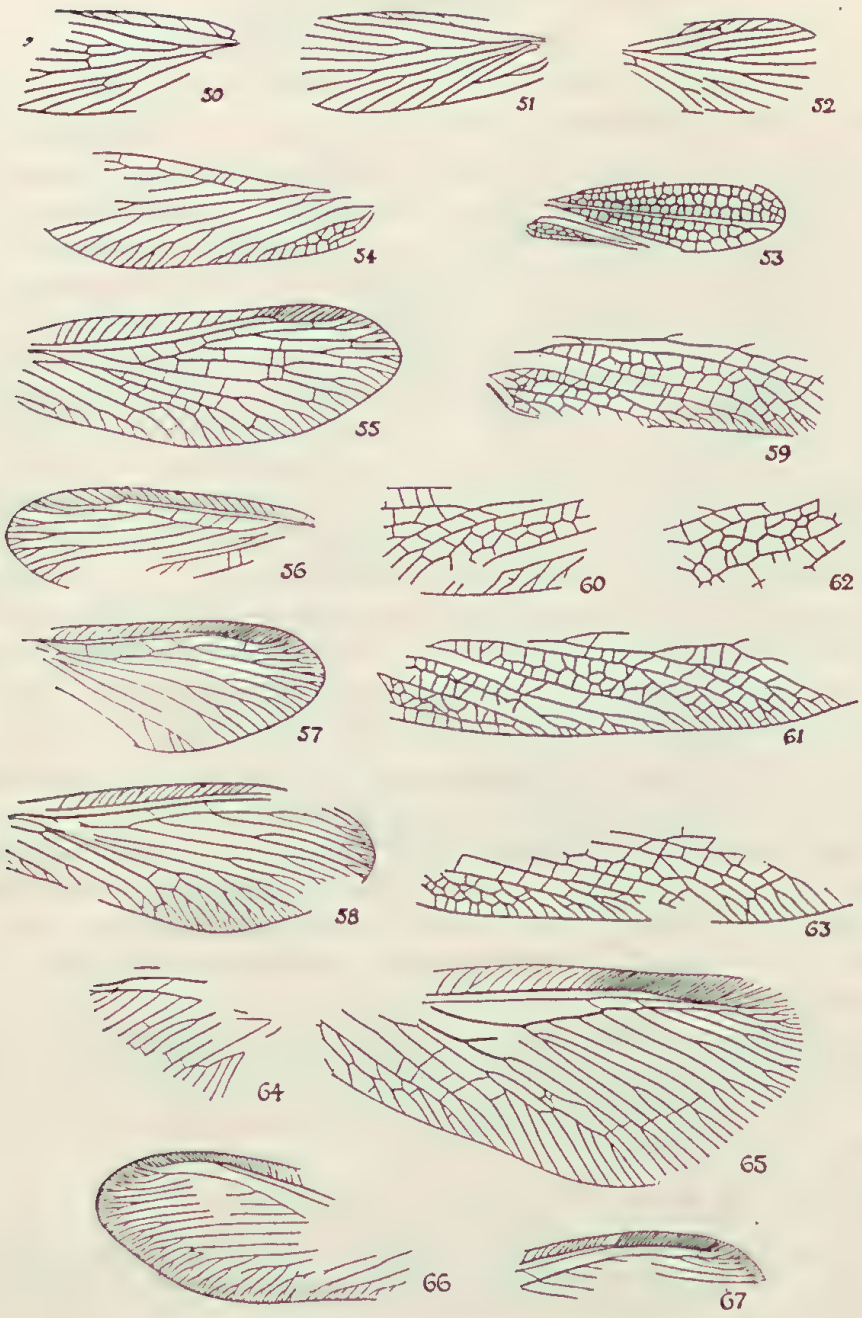
Forewing.—Costal space not greatly expanded, costal veinlets simple or at most forked; cross-veins between R and Rs limited in number, only three; 1A with only an apical forking, 2A and 3A well-branched but not enclosing an irregularly-reticulated area.

There is only one genus placed in the family, but *Eopsychops* Martynov 1933 from the Russian Permian may belong here. If so Martynov's interpretation of the venation is inaccurate. MA is fused with the stem of Rs and the vein he indicates as MA is really MP; MP is CuA; CuA is CuP; 1A is not labelled; A_1 is 2A and A_2 is 3A. It differs from *Permopsychops* in the late branching of MP and the forked CuP.

Genus **Permopsychops** Tillyard, 1926.

Genotype, *Permopsychops belmontensis* Tillyard, 1926.

Permopsychops Tillyard, 1926.
Permithone Davis, 1943 (in part).



Text-figures 50–67.

All figures x 3 ca.

50, F.28962, counterpart of holotype of *Cladochorista belmontensis* Tillyard.—51, F.41374, *Cladochorista belmontensis*.—52, F.40035, *Cladochorista belmontensis*.—53, F.42520, holotype of *Permoberothella perplexa*, sp. nov.—54, F.40272, *Permithone belmontensis* Tillyard, lower half.—55, F.40268, *Permithone belmontensis*.—56, F.28052, holotype of *Permithone oliarcoides* Tillyard.—57, F.40269, *Permithone oliarcoides*.—58, F.40271, holotype of *Permithone neoxenus*, sp. nov.—59, F.28053 *Permorapisma biserialis* Tillyard showing cubital and anal fields.—60, F.28051, *Permorapisma biserialis* (holotype of *triserialis* Tillyard).—61, F.40266, *Permorapisma biserialis* cubital and anal fields.—62, F.43076, *Permorapisma biserialis*.—63, F.40274 *Permorapisma biserialis*.—64, F.19793, holotype of *Permopsychops belmontensis* Tillyard.—65, F.39867, *Permopsychops belmontensis* (holotype of *Permithone venosa* Davis).—66, F.40264, holotype of *Archeosmylus pectinatus* sp. nov.—67, F.41000, *Archeosmylus pectinatus*. Fragment of hindwing.

Forewing.—Sc fused to R_1 distally; costal veinlets simple or at most branched, not connected by cross-veins; R and Rs connected by three cross-veins; Rs with numerous pectinate branches; M forking towards the base of the wing, before the forking of Rs; a distinct cubito-median Y-vein present, the M branch reduced; CuA branched, CuP simple; 1A forked near its apex, 2A and 3A branched.

The genus was placed provisionally in the Prohemerobiidae by Martynov (1928) along with *Eopsychopsis* from the Russian Permian but when the latter genus was removed to the Palaemerobiidae in 1933 no mention was made of *Permopsychops*.

Permopsychops belmontensis Tillyard, 1926.
(Plate vi, B, fig. 7; Text-figs. 64–65.)

Permopsychops belmontensis Tillyard, 1926, Proc. Linn. Soc. N.S.W., li, 281.

Permithone venosa Davis, 1943, Proc. Linn. Soc. N.S.W., lxviii, 11.

Forewing.—Length of wing 15 mm.; costal space not greatly expanded; Sc fused with R_1 at the pterostigma; R_1 only very slightly deflected by the pterostigma; costal veinlets simple or occasionally branched, without connecting cross-veins; the veinlets change the direction of their curvature in the region of the pterostigma; R_1 and Rs connected by only three cross-veins which are more or less limited to the apical half; Rs arising well towards the base of the wing, pectinately branched, the branches numerous, the most basal branch forking again almost immediately, the other branches generally forking at least once before the wing margin; M dichotomously branched, the first fork before the first fork of Rs, M_{3+4} forks again early but M_{1+2} only towards the wing margin; a distinct cubito-median Y-vein, arms unequal; CuA branched over almost the apical half, CuP simple; 1A forked near the wing margin, 2A and 3A branched, the branches connected by irregular cross-veins; intercubital cross-veins simple. There are distinct grooves in the wing between CuP and 1A and between 1A and 2A. These were interpreted as the veins Cu_2 and 2A by Consett Davis who went to some length to justify his conclusions.

The above description is based mainly on the type of *venosa* as the holotype is so fragmentary.

Type.—Holotype fragment F.19793 in the Australian Museum Collection (Specimen P.156 in Pincombe's Collection).

The type of *Permithone venosa* Davis is also in the Australian Museum Collection, F.39867. This specimen and the holotype are the only known specimens of the species. The type of *venosa* is a beautifully preserved wing, complete except for small areas at the base and apex. Tillyard's description of the type fragment is inaccurate in many respects, notably in the branching of M and CuA (all designated as M by Tillyard). The second specimen differs slightly from the holotype but not sufficiently so for specific separation.

Family ARCHEOSMYLIDAE, nov.

Resembling Recent Osmylidae, more especially Protosmylinae, but without regularly arranged gradate cross-veins and with simpler CuP and anal veins. CuP rather deeply forked but not pectinately branched; anal veins simple for most of the length but with short pectinate branches near the wing margin.

The family would seem to be derived directly from the Permithonidae (*Permithone*) by increased pectination of Rs, enlarged pterostigma, rather deep forking of CuP and more distinctly pectinate CuA.

Genus **Archeosmylus**, gen. nov.

Genotype, *Archeosmylus pectinatus*, sp. nov.

Forewing.—Costal veinlets, at least mainly, simple; pterostigma long; Sc fused with R_1; Rs with numerous pectinate branches (at least ten), end-twigging dense; CuA with (at least four) pectinate branches; CuP deeply forked; 1A and 2A pectinately branched near apex, 3A less so, short.

Hindwing.—Pterostigma very long and not reaching so far round towards apex, but otherwise an anterior margin similar to the forewing; CuA with (at least six) pectinate branches.

Archeosmylus pectinatus, sp. nov.

(Plate vi, B, fig. 10; Text-fig. 66–67.)

Forewing.—Length of wing 11 mm.; costal space not greatly expanded, slightly so over the basal half; Sc fused to R_1, both veins bending at the point of fusion; pterostigma long and relatively narrow; Rs arising near base of wing, pectinately branched, number of branches large, each branch forking a number of times near the wing margin, so that the end-twigging is rather dense; M abundantly branched, dichotomously near the wing margin; CuA with abundant pectinate branches, at least five and each of these forks before the wing margin, the most basal one preserved forks twice; CuP only partly preserved, connected to CuA by simple cross-veins; 1A straight, with only slight end-twigging; 2A straight, pectinately branched near apex, five or six branches, but all short; 3A short, only slightly branched. A single free short intercalary at the wing margin between all of the terminal branches of the veins.

Hindwing.—Preserved portion similar to forewing, but pterostigma very long and narrow and CuA with at least six pectinate branches, each branch forking before the wing margin.

Type.—Holotype F.40264, an almost complete forewing (with fragments of an overlying hindwing and another pair of overlapping wings), and paratype F.41000, fragment of a hindwing, in the Australian Museum Collection.

F.41342 and counterpart F.41343 is referred doubtfully to this species.

The species is only imperfectly preserved, but the structure of CuA and the anal field and of the pterostigma are characteristic. A notable feature is the clear preservation of the regular short intercalary veins, which are very obvious in the better preserved forewing.

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Explanation of Plate V.

A. Figures 1–17.—*Mesochorista australica* (Tillyard) x 3 ca.

1, F.41286, perfect wing.—2, F.41040, perfect wing.—3, F.40189, perfect wing.—4, F.40141, extra branch on M_3.—5, F.40801, reduced branching on M, M_2 simple.—6, F.40229, extra branch on M_1.—7, F.39317, type of *mitchelli* Till., showing reduced branching of M, M_2 simple.—8, F.40133, hindwing, preserving anals.—9, F.40213, hindwing, with an extra twigging on M_2.—10, F.39982, forewing preserving wing pigmentation-pattern.—11, F.40124, forewing preserving wing pigmentation-pattern.—12, F.40149, forewing preserving wing pigmentation-pattern.—13, F.40802, reduced branching of M, M_2 simple.—14, F.29031, type of *collinsi* Till., R_2 shows an additional twigging.—15, F.40132, hindwing, with deep forking of $R_3 + _5$.—16, F.40224, hindwing, with reduced forking of $R_2 + _3$.—17, F.40208, specimen preserving all four wings, but each forewing with only a five-branched M.

B. All figures x 3 ca.

1, *Mesochorista phipa*, sp. nov. F.40180.—2, *Mesochorista phipa*, sp. nov., holotype, F.40125.—3, *Mesochorista dubia*, sp. nov., holotype, F.41287.—4, *Mesochorista jucunda* (Tillyard), holotype, F.38269.—5, *Mesochorista jucunda* hindwing, F.42495.—6, *Permomerope australis* Tillyard, holotype hindwing, F.28045.—7, *Permomerope australis* Tillyard, forewing, F.40108.—8, *Parachorista splendida* Tillyard, holotype, F.28048.—9, *Parachorista splendida* Tillyard, F.41094.—10, *Parachorista pincombeae* Tillyard, type of *mitchelli* Till., F.28049.—11, *Parachorista pincombeae* Tillyard, holotype, F.38272.—12, *Belmontia mitchelli* Tillyard, holotype, F.28469.—13, *Belmontia mitchelli* Tillyard, F.40970.—14, *Parabelmontia permiana* Tillyard, F.28461.

Explanation of Plate VI.

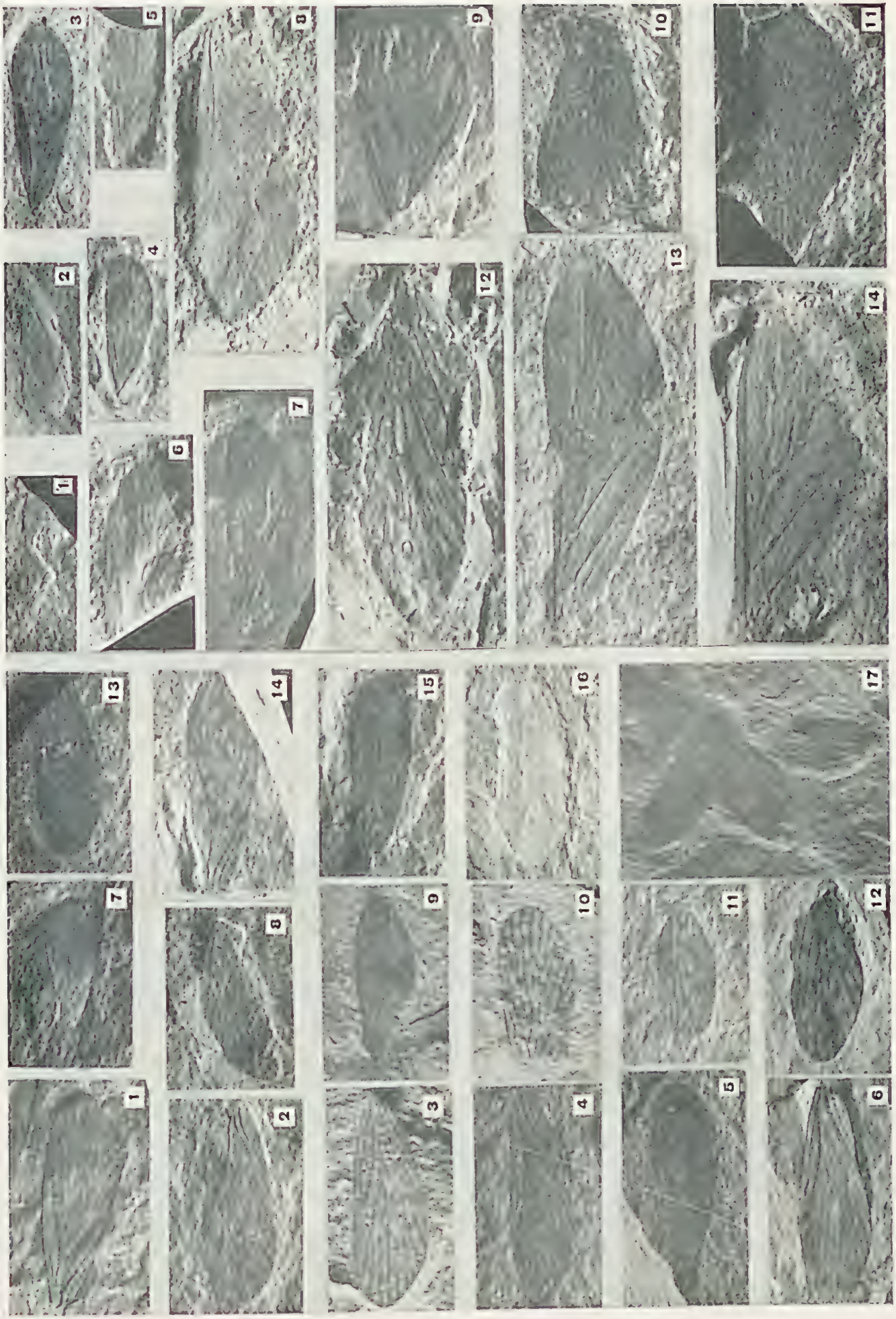
A. All figures x 3 ca.

1, *Phipoides elegans*, gen. et sp. nov., holotype, F.40144.—2, *Neopetromantis australis*, gen. et sp. nov., holotype, F.40211.—3, *Neopetromantis australis*?, F.43122.—4, *Agetochoristella adscita*, gen. et sp. nov., holotype, F.43656.—5, *Agetochoristella adscita*, gen. et sp. nov., F.46223.—6, *Neoageta elongata*, gen. et sp. nov., holotype, F.43969.—7, *Cladochorista belmontensis* Tillyard, F.40035.—8, *Cladochorista belmontensis* Tillyard, counterpart of holotype, F.28962.—9, *Xenochorista splendida*, gen. et sp. nov., holotype, F.40157.—10, *Xenochorista sobrina*, sp. nov., holotype, F.43123.—11, *Xenochorista sobrina*, sp. nov., F.43101.—12, *Mesopanorpodes belmontensis*, sp. nov., hooltype, F.40166.—13, *Mesopanorpodes belmontensis*, sp. nov., hindwing, F.41237.—14, *Mesopanorpodes robustus*, sp. nov., holotype, F.40787.—15, *Mesopanorpodes wianamattensis* Tillyard, holotype, F.39326.—16, *Prochoristella megaloprepia*, gen. st sp. nov., F.40123.—17. *Prochoristella megaloprepia*?, showing body, F.40081.—18, *Prochoristella exilis*, sp. nov., holotype, F.40168.—19, *Prochoristella pusilla*, sp. nov., F.41091.—20, *Prochoristella belli* (Tillyard), holotype, F.19795.—21, *Prochoristella belli* (Tillyard), F.39873.—22, *Prochoristella concinna*, sp. nov., holotype, F.40182.—23, *Permotanyderus ableptus*, gen. et sp. nov., holotype, F.40675.—24, *Permoberothella perplexa*, gen. et sp. nov., holotype, F.42520.

B. All figures x 3 ca.

1, *Permithone belmontensis* Tillyard, variant, F.40268.—2, *Permithone belmontensis* Tillyard, F.40156.—3, *Permithone belmontensis* Tillyard, F.40272.—4, *Permithone neozenus*, sp. nov., holotype, F. 40271.—5, *Permorapisma biserialis* Tillyard, F.40266.—6, *Permorapisma biserialis* Tillyard, holotype, F.28053.—7, *Permopsychops belmontensis* Tillyard, holotype of *venosa* Davis, F.39867.—8, *Permithone oliarcoides* Tillyard, F.40269.—9, *Permithone oliarcoides* Tillyard, holotype, F.28052.—10, *Archeosmylus pectinatus*, gen. et. sp. nov., holotype, F.40264, lower specimen.

Sydney: A. H. Pettifer, Government Printer—1953.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CARCINOLOGICAL NOTES

No. 2.*

By Frank McNeill.

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(Plate vii.)

The contribution is an accumulated collection of observations on Decapoda from the western Pacific Ocean region, notably eastern Australia. Included are several interesting additions to the Australian fauna, arguments in support of the relegation of certain species to the synonymy of earlier established names, and notes on some newly acquired material which serve to ratify the presence in Australian waters of early recorded species.

In the illustrations of *Medaeus haswelli* and of the carapace of *Manella spinipes* are seen some interesting results of a photographic technique having great possibilities with subjects of small size. The originals of these were made by Mr. H. Hughes, A.R.P.S., of the Museum staff, with the aid of a 2½ inch focal length lens and critically arranged lighting.

Family Palaemonidae.

Genus **Anchistus** Borradaile.

Anchistus gravieri Kemp.

Kemp, Rec. Indian Mus., xxiv, II, 1922, 252, figs. 82-84.

The present pair of specimens appear to be the first seen since the species was described from a single example in the Paris Museum. Kemp was unable to name a host for his holotype, and it is doubly interesting to record here a normal and expected habitat for the genus. A critical comparison of the specimens with Kemp's description and figures shows the only slight difference to be an understandable variation in the total of spinules on the dorsum of the rostrum. The female and larger example of the pair (18.5 mm. between rostrum and telson) bears five spinules, but the male rostrum is as illustrated by Kemp.

The colour of the specimens when received (freshly preserved in formalin) was a light orange ground, with dark orange-red spots scattered over both body and limbs.

Locality.—Tarawa I., Gilbert Grp., Polynesia; from the mantle folds of a species of *Pinna*. Collected Dr. J. R. Catala of Noumea, New Caledonia.

Previously recorded from Vanikoro, Santa Cruz Is., Polynesia.

Family Palinuridae.

Genus **Linuparus** Gray.

Linuparus trigonus (von Siebold).

Palinurus trigonus, de Haan, Siebold's Fauna Japonica, Crust. v, pt. v, 1841, 157, Pls. 39-40.

Puerulus carinatus, McNeill (*nec.* authors), Aust. Mus. Mag., ix, 10, 1949, 337, illustration.

Linuparus trigonus, Barnard, Ann. Sth. African Mus., xxxviii, 1950, 820 (refs.).

*Carcinological Notes, No. 1, McNeill and Ward, 1930, Rec. Aust. Mus., xvii, No. 9, p. 357.

A fine example of the species was received by the Australian Museum in Sept., 1948, and constitutes a notable addition to the Australian marine fauna. It has an overall length of 16 inches, and when fresh the colour markings were cream, pink and red, with the thick, short antennae a brighter red than elsewhere.

In a popular account (*tom. cit.*) the unfortunate error was made of recording the species under an incorrect name. Dr. Barnard was one of several who drew attention to this fact by letter. He has since, in his monograph (*tom. cit.*), mentioned the present record as "apparently the same species" as the above and makes mention of the misidentification. The specimen has now been critically checked and there is no doubt about its true identity.

Locality.—Off Botany Bay, N.S.Wales, 65 fathoms; from the net of a steam trawler. Presented Capt. T. H. Webb.

Distribution.—Japan; Portuguese East Africa; N.S.Wales, Australia.

Family Porcellanidae.

Genus **Neopetrolisthes** Miyake.

Neopetrolisthes ohshimai Miyake.

Miyake, Zoological Mag., 49, 1 (Kyushu Imperial Univ., Fukuoka), 1937, 34, figs. 1-2.

When this unusual crab associate of a sea anemone was described, the author commented that he was unaware that any representative of the "group as commensal with other animals has ever been discovered in the Indo-Pacific region". It is doubted that a second record of the species has ever been published. In view of this the facts that can now be supplied should be of interest to carcinologists: the range of the species can be considerably extended and a noteworthy addition be made to the Australian fauna.

The receipt of a female example (carapace 12 mm. wide) collected from a "large violet *Stoichactys*" by Dr. J. R. Catala of Noumea, led to the present identification. It also facilitated the naming of another smaller female in the Australian Museum collection. Both examples agree perfectly with Miyake's description and figure of the female allotype.

Localities.—Makaluva, Fiji Is. (Dr. Catala); Hope I., North Queensland—collected late A. R. McCulloch ("commensal of *Discosoma*"). Previously known from "coral reef, Shika, Ishikaki-shima, Yæyama-Group, Riukiu Iss."

A further interesting discovery is that an old record of Saville-Kent's (1897)*, dealing with a commensal crab (unnamed) from the Great Barrier Reef, Queensland, can now also be associated with the present species. The accompanying illustration shows the crab among the tentacles of the anemone, *Discosoma*. It is a reproduction from a photograph and dark shading is present over most of the crab's carapace and in patches over the upper surfaces of the hands and propodi of the chelipeds. This marking suggests a variation from the typical red spotting on a cream ground, but might be due to shadow. Despite it, however, and the impossibility of checking details of the finer characters, the record is considered safely applicable to the present species.

In 1923† reference was made to Saville-Kent's illustration by McCulloch and McNeill. when it was referred to as "an unidentified crab of the family Porcellanidae" to be found associated with the fish *Amphiprion percula*, and the shrimp *"Periclimenes (Ancylocaris) brevicarpalis"*,‡ in the large anemone, *Discosoma*.

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*Naturalist in Australia, p. 220, Pl. 39.

†REC. AUST. MUSEUM, xiv, 1, p. 58.

‡Now *P. (Harpilius) brevicarpalis* (Schenkel).

Family Raninidae.

Genus **Lyreidus** de Haan.

Lyreidus tridentatus de Haan.

Lyreidus tridentatus de Haan, Siebold's Fauna Japonica, Crust. v, 1841, 140, Pl. xxxv, fig. 6; Haswell, Cat. Aust. Crust., 1882, 144; Henderson Rept. "Challenger", Zool., xxvii, Anomura, 1888, 33; Whitelegge, Mem. Aust. Mus., iv, 2, 1900, 165; Sakai, Studies on Crabs of Japan, II Oxystomata (Sci. Rpts. Tokyo Bunrika Daigaku, Sectn. B, Suppl. 2), 1937, 169, Pl. xvi, fig. 5.

Lyreidus australiensis Ward, Aust. Zoologist, 7, 5, 1933, 377, Pl. xxiii, fig. 10; Sakai, *tom. cit.*, 1937, 168; Richardson and Krefft, Tuatara, ii, 2, (Journ. Biol. Soc. Vic. Univ. College, N. Zeal.), 1949, p. 69.

It seems necessary to introduce into Australian literature some notice of the discredited status of Ward's *L. australiensis*. Sakai (1937) in his monumental work on the Crabs of Japan deals with all known species of *Lyreidus*, and states that "the discriminations enumerated by Ward between *australiensis* and *tridentatus* are artificial, and I am quite at a loss how to discriminate these species". Richardson and Krefft (1949) were unaware of this opinion of Sakai's when they published their record of a unique female specimen from New Zealand waters under the name *L. australiensis*. They did, however, qualify this by stating that "the present specimen fits well with Haswell's description from Australian specimens, agrees with Bourne's figures* of the venter and of various appendages, etc., of an Australian specimen, and other than in the hands, which are not as heavy, with the photograph of Ward's holotype male". Earlier, the present author had grave doubts as to the validity of *australiensis*, for there are so many species of the Decapoda common to both Japan and Australia. It was arranged with Sakai to send Japanese examples of *L. tridentatus* to the Australian Museum. A critical comparison of these with Ward's holotype male of *L. australiensis* in the Australian Museum collection fully supports the claim that the two species are identical.

Family Leucosiidae.

Genus **Nursia** Leach.

Nursia abbreviata Bell.

Bell, Trans. Linn. Soc., Zool., xxi, 1855, 303, Pl. xxxiv, fig. 5; Miers, Rep. Zool. "Alert", 1884, 253; Alcock, Journ. Asiat. Soc. Bengal, n.s., lxv, ii, 2, 1896, 180, 184 (references); Ihle, Rés. explor. "Siboga" Expd., Monogr. xxxixb^2, 1918, 235, 311.

Miers (1884) published the first Australian record of this species, based on specimens from Moreton Bay, Queensland, in the collection of the British Museum. Another specimen recently acquired by the Australian Museum from the same locality has drawn attention to the older record, and provides the means of verifying the occurrence. Furthermore, a check of the collection in the same institution has disclosed three additional specimens which considerably increase the range of the species along the eastern Australian coastline. The hub of distribution appears to be in the northern Indian Ocean. It is doubted whether there are any records in literature from intermediate localities between there and the eastern Australian waters.

Localities.—Manly, Moreton Bay, Queensland; mud, zostera, etc. One female, 9 mm. wide. Coll. J. S. Hynd, 27 July, 1946.—Bowen Harbour, Port Denison, Queensland. One male, 7 mm. wide, from stomach of small whiting (fish). Coll. E. H. Rainford, 1925.—Port Jackson, New South Wales, 7 fathoms. One male, 9 mm. wide. Coll. F. E. Grant. Another female specimen, 13 mm. wide, from the same locality, has no other details than the date collected—11th June, 1902.

Distribution.—India; eastern Australia.

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*Journ. Linn. Soc., Zool., xxxv, No. 231, 1922.

Family Majidae.

Genus **Paramithrax** H.M.Edw.

Paramithrax latreillei Miers.

Paramithrax barbicornis Miers, Ann.Mag.Nat.Hist. (4), xvii, 1876, p. 219 (*nec Pisa barbicornis* Latr., 1825); Miers, Cat.Crust.N.Zeal., 1876, 6, Pl. 1, fig. 2; Haswell, Cat.Aust.Crust., 1882, 13.

Paramithrax latreillei, Miers, Ann.Mag.Nat.Hist. (4), xvii, 1876, p. 220; Rathbun, Proc.U.S.Nat.Mus., xvi, 1893, 66 and 82 (refs. and synonymy).

A review of literature discloses that this species has, until now, not been recognized with certainty from the Australian region. Miers' somewhat confused early references under the name *P. barbicornis* (Latr.) give the impression that it was readily accessible and abundantly represented in Australia. Haswell in 1882 (*tom. cit.*) was very definite in doubting the occurrence when he stated that "no specimens of the New Zealand species referred to *P. barbicornis* by Mr. Miers are known with certainty to have been found in Australia". Subsequent evidence has proved that the species, now established as *P. latreillei,* has its principal habitat in New Zealand waters; it is one of the commonest of the six members of its genus found there and grows to a comparatively large size. Authentic Australian specimens have seemingly not been collected until the last couple of years. These serve to ratify the presence of *P. latreillei* in the Australian marine fauna after a lapse of nearly eighty years since it was first described.

While two of the three specimens in the Australian Museum collection are from New South Wales, the species is considered to occur more rarely along this eastern seaboard than it does in sheltered positions along the Victorian coast. During the course of a recent searching ecological study in Victoria my colleague, Miss E. Pope, listed it as fairly common in weed growths between tide marks at a number of localities.

Localities.—Shark Is., Port Jackson, N.S.Wales; under stones between tide marks. One female (carapace 27 mm. wide); collected R. Mackay—Moruya Heads, N.S.Wales. One male (carapace 14 mm. wide); collected Miss E. Pope—Walkerville, Waratah Bay, Victoria; under stones between tide marks. One male (carapace 25 mm. wide); collected Miss E. Pope.

Distribution.—New Zealand, south-eastern Australia.

Family Cancridae.

Genus **Carcinides** Rathbun.

Carcinides maenas (Linn.)

Carcinus maenas, Alcock, Journ.Asiat.Soc.Bengal, n.s., lxviii, ii, 1, 1899, 13 (references); Fulton and Grant, Victorian Naturalist, xvii, 8, 1900, 145.

Carcinides maenas, Rathbun, Bull.U.S.Fish.Comm., xxiii (for 1903), pt. iii, 1906, 867.

The unusual distribution of this common North Atlantic and Mediterranean species of shore crab has been enlarged upon by Alcock (*tom. cit.*). He records a penetration eastwards to the Red Sea and India, mentions a reported occurrence in the Hawaiian Is., central Pacific Ocean, and adds "Australia" as an additional but doubtful locality. Only a year later Fulton and Grant (*tom. cit.*) recorded the species as common in Port Phillip, Victoria, emphasizing that the occurrence was of comparatively recent origin and that the crab was probably introduced. They could have

claimed verification of Alcock's doubtful Australian record, but apparently were not aware of this. Since 1900, no further reference has appeared in Australian literature and it is therefore considered opportune to record some additional data.

In 1951 it was noted that the species is well established on the shores of the open coast in Victoria at a place nearly 400 miles north-eastward and northwards from Port Phillip. It is firmly believed that this increase in range has occurred since 1900. The specimens have been critically checked and there is no possibility of error in their identification.

Locality.—Coast near entrance to Mallacoota Inlet, Victoria. Two adult specimens taken from hiding places in rock crevices in the high littoral zone. Collected Miss E. Pope. From the number of additional examples observed it was obvious that the species was quite common.

Family Portunidae.

Genus **Aeneacancer** Ward.

Aeneacancer mölleri Ward.

(Plate vii, figs. 1, 2.)

Ward, Aust.Zoologist, vii, pt. v, 1935, 381, Pl. xxiii, fig. 11.

All the known material of this striking species has been secured by the one collector. Since it was described and figured a large number of excellently preserved specimens has been received by the Australian Museum, including one example which is the only known female. Opportunity has been taken of comparing the characters of the additional material with Ward's lengthy description of the male. Figures can now also be provided of (*a*) the female abdomen, and (*b*) a perfect male specimen, superior to the one published of the incomplete holotype which is lodged in the Australian Museum. An examination of the single female specimen shows that the general characters agree closely with those of the male except for the proportionately shorter chelipeds. The female abdomen is a little more than 1½ times longer than broad, while the length of the fifth segment is nearly twice that of the fourth.

The nearest relative of *A. mölleri* is *Ovalipes iridescens* (Miers)* from 140 faths., near the Ki [Kei] Is., west of New Guinea. The body colour of the latter has the same highly iridescent sheen, but it lacks the pair of characteristic, semi-transparent, tympana-like areas present on the carapace of *A. mölleri*. It is a matter for regret that Ward has introduced another generic name into nomenclature. In every way his *Aeneacancer* has affinities with the well-established genus *Ovalipes*.

Localities.—Off Broken Bay, N.S.Wales, 120 faths.; 26 adult males and 1 ovig. female. About 20 mls. W. of Babel Is., Bass Strait, 80-85 faths.; 1 adult male. All the specimens were collected by Capt. K. Möller when in command of steam fish trawlers.

The damaged male holotoype (Reg'd No. P.10623) was taken by the steam trawler "Durraween" S. of Montague I., N.S.Wales, in approximately 40 faths. A series referred to by Ward as from E. of Port Jackson, N.S.Wales, 110 faths., is, presumably, still in that author's possession.

Family Xanthidae.

Genus **Hypothalassia** Gistel.

Acanthodes de Haan, Siebold's Fauna Japonica, Crust. i, 1833, 20. Genotype, *Cancer* (*Acanthodes*) *armatus* de Haan, *tom. cit.*, ii, 1835, 52.

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* Rpt. "Challenger", Zool., xvii, Pt. xlix, 1886, 202, Pl. xvii, figs. 2-2d.

It has apparently been proved by Gistel (Naturg. Thierreich hoh Schulen, 1848, p. viii) that this monotypic genus is preoccupied by *Acanthodes*, of Agassiz in Poiss. Foss., ii, 1, 1833, p. 19.

Hypothalassia armatus (de Haan).

Cancer (Acanthodes) armatus de Haan, Siebold's Fauna Japonica, Crust. ii, 1835, 52, Pl. B (part) and Pl. lv.

Acanthodes armatus Rathbun, Biol. Res. F.I.S. "Endeavour", v. 3, 1923, 128, Pls. xxxi-xxxii, fig. 1 and text-fig. 3 (references); Sakai, Studies on the Crabs of Japan, iv, 1939, 516, Pl. lxiii (references); McNeill, Aust. Mus. Mag., ix, 10, 1949, 338, illustr.

A large and striking male of this species (McNeill, 1949) was received in a fresh condition at the Australian Museum in 1948; it measures five inches across the widest part of the carapace. Splashes of bright red were distributed over a general ground colour of pale pink to cream; the bases of the numerous long spines were brown.

The occurrence constitutes a notable extension of range southward along the eastern Australian coast. Previously the only specimens from an Australian locality were those taken by the F.I.S. "Endeavour" off the southern coast in depths between 80-190 fathoms. In that case the route of distribution must have been along the western coast of the continent. There is ample evidence to support the belief that species of Decapoda from warm water regions are unable to cross the barrier of cold temperate water in Bass Strait and environs.

Locality.—10 miles east of Point Plummer, north of Hastings River, New South Wales, 65 fathoms; from a crayfish-pot. Collected by T. Radley, fisherman.

Distribution.—Japan; Great Australian Bight, South Australia; N.S.Wales.

Genus **Lydia** Gistel.

Lydia annulipes (H.M.Edw.).

Ozius, Euruppellia annulipes Alcock, Journ. Asiat. Soc. Beng., n.s., lxvii, ii, 1, 1898, 188 (references and synonymy).

Euruppellia annulipes Miers, Rep. Zool. "Alert", 1884, 533 (refs.).

Lydia annulipes Rathbun, Bull. U.S. Fish. Comm., xxiii (for 1903), pt. iii, 1906, 862; Sakai, Studies on the Crabs of Japan, iv, 1939, 521, 719, Pl. lxiv, fig. 3 (refs.).

No Australian record of this unmistakable and widely distributed Oriental species has previously been published. The nearest locality is Woodlark I., Louisiade Archip., S.E. New Guinea, given by Haswell in 1882 (Cat. Aust. Crust., p. 73).

Locality.—Brampton I., near Mackay, Queensland; shoreline, among oyster growths. Two adult specimens, male and female. Coll. A. Keast.

Distribution.—Northern Indian Ocean; East, South-west, Central and South Pacific Ocean.

Genus **Medaeus** Dana.

Medaeus haswelli Miers.

(Plate vii, figs. 3, 4.)

Miers, Report "Challenger", Zool., xvii, pt. xlix, 1886, 117, Pl. xi, figs. 2-2c.

This small species was described from three incomplete specimens (two males and one female—largest with carapace 8.5 mm. wide) secured off Twofold Bay, New South Wales, in 150 fathoms. The present record verifies the occurrence in the area

after a lapse of more than sixty-five years, and is the first mention of the species in Australian carcinological literature. One example, an ovigerous female, is proof of an adult state; on this point Miers expressed some uncertainty. Except for two missing ambulatory limbs in one specimen, the newly found material is perfect; it has been critically compared with the original description and figures. The only comment that should be made is that the granulation of the large cheliped is more prominent than shown by Miers and covers the whole surface of the palm (see figure).

Localities.—About 7 miles off Twofold Bay, N.S.Wales, 45 fathoms; Oct., 1929; one female with carapace 9 mm. wide. W.S.W. from Gabo I., N.S.Wales, 70 fathoms; Dec., 1929; one female (ovig.) with carapace 8.5 mm. wide.

Both specimens collected by Capt. K. Möller, steam trawler "Durraween".

Distribution.—South-eastern Australia.

Family Grapsidae.

Genus **Plagusia** Latr.

Plagusia dentipes de Haan.

Grapsus (*Plagusia*) *dentipes* de Haan, Siebold's Fauna Japonica, Crust., pt. ii, 1835, 58, Pl. viii, fig. 1.

Plagusia dentipes Grant and McCulloch, Proc. Linn. Soc. N.S.Wales, xxxii, 1, 1907, 153; Rathbun, in Stimpson, Smith. Misc. Colls., xlix (No. 1717), 1907, 122 (posthumous work); Sakai, Studies on the Crabs of Japan, iv, 1939, 702, 732, Pl. lxxix, fig. 3 (references). Sakai, Studies on the Crabs of Japan, iv, 1939, 702, 732, Pl. lxxix, fig. 3 (references).

Based on Japan, this species apparently has a wide range southwards. It has been noted as common at Norfolk and Lord Howe Islands by Grant and McCulloch. A number of specimens from these localities is in the Australian Museum collection, but until now there has been no record of the species from the Australian mainland. The present newly recorded material has been critically checked with de Haan's excellent figure and constitutes an addition to the Australian marine fauna.

Localities.—Brennan Shoals, off Cape Moreton, south Queensland; clinging to growths on a light buoy. Two adults, coll. by S. Hynd, 18.12.46—Caloundra, south Queensland. Two juvs. (one small) and one megalop stage, coll. by A. A. Livingstone, 12.8.22—Point Cartwright, south Queensland. One adult and one small juv., coll. by A. A. Livingstone, 2.8.22.

Distribution.—Japan; Formosa; Easter I., eastern Pacific; Norfolk and Lord Howe Islands, south Pacific; eastern Australia.

Family Palicidae.

Genus **Manella** Rathbun.

Manella spinipes (de Man).

(Plate vii; figs. 5, 6.)

Pleurophricus spinipes de Man, Archiv fur Naturg., liii, 1, 1887, 344, Pl. xv, fig. 1.

Manella spinipes Rathbun, Bull. U.S. Fish. Comm., xxiii (for 1903), pt. iii, 1906, 837, Pl. vii, fig. 6 and text-fig. 3; Sakai, Studies on the Crabs of Japan, iv, 1939, 610, Pl. ciii, fig. 3.

Manella brevimana Ward, Aust. Zoologist, vii, v, 1933, 387, Pl. xxi, figs. 7-8.

Synonymy.—Sakai's work (1939) has an excellently reproduced photograph of the first recorded Japanese specimen of this species. It was this that confirmed the present decision reluctantly to place Ward's species, *M. brevimana* in the synonymy of *M. spinipes*. The male holotype of *M. brevimana* is from Queensland and is in the Australian Museum collection (Regd. No. P. 10636). Its accessibility has also enabled a critical comparison with de Man's description and figure (1887) of his holotype from Amboina, and with Rathbun's well reproduced photograph of an Hawaiian specimen (1906); Ward's figure is a very sketchy representation of his holotype. It is obvious that *M. spinipes* has a very wide range in the Pacific Ocean, and in a species with such abundant spinulation a certain minor variation can be expected. Furthermore, it is more than reasonable to expect that a species occurring in Amboina would range as far south as the Queensland coast; many eastern Australian species of Decapoda have a distribution which extends far beyond the East Indian region into the more distant Indian Ocean.

In a tabulated list of the characters of known species of *Manella,* Ward made an attempt to separate his *brevimana* from *spinipes,* but the differences recorded are neither convincing nor substantial.

EXPLANATION OF PLATE vii.

Aeneacancer molleri Ward.

1.—Adult male; carapace 93 mm. wide. *Locality.*—Off Broken Bay, N.S.Wales, 120 fathoms.

2.—Abdomen (34 mm. long) of ovig. female; carapace 68 mm. wide. Same locality as adult male.

Medaeus haswelli Miers.

3.—Ovig. female; carapace 8.5 mm. wide. *Locality.*—W.S.W. from Gabo I., N.S.Wales, 70 fathoms.

4.—Chelipeds of same specimen.

Manella spinipes (de Man).

5.—Male holotype of *M. brevimana* Ward; carapace 17 mm. wide.

6.—Carapace of same.

A CIRCUMCISION CEREMONY AND STONE ARRANGEMENT ON GROOTE EYLANDT

By Frederick D. McCarthy, Dip.Anthr. (Syd.).

Curator of Anthropology, The Australian Museum, Sydney.

(Plate viii; Text-figures 1-10.)

On the evening of April 19th, 1948, a circumcision ceremony began at Umbakumba (Fig. 10), Little Lagoon, in the north-eastern corner of Groote Eylandt, and each night afterwards the whole camp held a dance on the beach beside the lagoon until May 19th, when the ceremony continued throughout the night. The operation was performed on the initiates at dawn the following morning. I witnessed this ceremony from beginning to end, and visited a group of cave paintings known as Jundurruna at Amalipa, and a stone-arrangement at Lake Hubert connected with it. The Groote Eylandt natives are distinguished as the Ingura tribe.

Preliminary Dances.

The initiates, all of whom were about seven years of age, sat on a blanket in front of the musicians who played wooden drone-tubes (*jiraga*) and used fluted non-returning boomerangs* as clap-sticks. The faces of the initiates had a broad yellow band painted across the middle, one over the nose and up to the forehead, and one just below the eyebrows. The bands were outlined with white dots and bore a median white stripe. The initiates also wore the following ornaments; a white-cockatoo feather head-plume; a head circlet of ruddled possum cord on each end of which is suspended up to five wallaby incisor teeth in one set and a number of shell-valves in the other set; armlets of plaited cane covering the greater part of the upper arm. They were seated in the same way as a rule but appeared to reverse their individual positions on each alternative night.

One *jiraga*, whose distal end was placed in a hollow petrol-can resonator †, and three pairs of clap-sticks were employed, but sometimes only one *jiraga* and one pair of clap-sticks were in use. One stick was long and was either laid on the ground or held upwards, the other a short one used as a striker. The clap-stick players sang the songs. The musicians were usually seated at right angles to the dancers and about fifteen yards from them. The drone-tube rhythms varied considerably but they were generally short and sharp in character.

For evening after evening the stingray (Imadoija) totemic (*alawadawara*) dance was performed by fifteen men led by Tatalara, one of the most influential men on the island, who lives at Onguruku. Although this was the only dance performed, the songs played and sung included both Imadoija (stingray) and Mamariga (south-east wind) cycles. The dance was repeated a number of times during the evening and the performance usually took from an hour to an hour and a half. On each night the first portion of the dance was the same, but on alternate nights one of two variations of the second portion was performed.

In the first portion of the dance the main group of thirteen men flexed their knees forward and lifted their feet alternately for some time. Then two men, who acted as leaders in front of the group, walked around the group, one at the back and one in front, then back again, and repeated the movement; each carried a lath

* These are obtained by trade from the *Nungubuju* tribe on the mainland, who get them from the natives further south.

† Normally a bailer shell is used for this purpose.

spear-thrower which he moved up and down very smartly from above one shoulder to across the belly. They all brought their knees together very quickly and hopped to one side or the other once or twice with feet apart, and then back again, turning at right angles to one another, and emitting *ssh, ssh, yeh, yeh, eah, eah,* and finishing on *ja, ja.* The women were seated in several groups to one side during this dance.

The men then rested for five minutes until Tatalara, representing a big Imadoija, came forward, holding a pair of clap-sticks, to join the main group of thirteen men with the painted initiates in the middle, the boys being held by their own fathers. Tatalara chanted the accompanying song. The names of the various dance movements are as follows:

Double-footed hop: *No-gwa-bitjunga.*
Knee flexed, foot lifted: *Na-dju-bitjunga.*
Two men walking around group: *Nowilja-maitia.*
Fluttering hands: *Naugwa-runda.*

The initiates are called *no-umbarunga,* their facial design *maadrunga,* and their head ornament *ubraita* after the wallaby teeth.

In the first version of the second portion of the dance, one of the two leading men remained on each side of the main group, and when proceeding one behind the other they fluttered their hands, which were held horizontally with the spear-thrower in one, to represent the movements of the Imadoija's fins; they stood with their legs apart and slightly flexed; sometimes they hopped on one leg. The boys were placed on their father's shoulders symbolizing an old Imadoija picking up young ones.

Tatalara chanted a short song about another stingray (Kalakuruma) which belongs to a trio of totems—Imadoija, Kalakuruma, and the sawfish, Ingurudungwa—and he then walked to the front of the group, the members of which emitted and ejaculated various noises. The group then paraded slowly forward for about ten feet and returned, and the two solo dancers, representing stingrays swimming along the bottom, walked across, one behind and one in front of the group, each holding a spear-thrower as the tail of a stingray; the two dancers returned to their positions on each side of the group, and each hopped upwards on one leg, the other being flexed. When Tatalara and others called out *ka-wu* (salt water) the group, preceded by the two men behind one another, and representing a lot of stingrays swimming about, paraded for a distance of about thirty feet and returned. When this action was repeated the two leaders hopped along until all stopped and Tatalara began chanting *Brr., Brr.,* indicating that many young stingrays were swimming away in all directions. The initiates were kept in the middle of the group of men, which turned about, paraded ten feet forward and returned, when all of them emitted numerous *Brrs.*

The second version of the second portion of the dance was slightly more dramatic. The two leading men, as Imadoija, carried shovel-nosed spears. They repeated the action of walking around the back and front of the group, returned to their position in front and opposite one another, pointed the spears (which should have been armed with stingray-spines, *tungurakwa*) at one another as though fighting, then held them in an arc (the spear being bent downwards at each end) above their head, and in another arc upward at waist height, to represent the Imadoija sitting down or camping during the *Aropoia* or dream-time. They then walked along in file in front of the group, as it paraded forwards, and when they bent their spears they represented two old-men Imadoija hunting another invisible one in front of them whom they could not find because he was swimming along the bottom. This action was repeated three times. The group then re-assembled, and emitted many *Brrs,* sang and clapped their hands. The boys were again hoisted upon their father's shoulders—the dispersal of the little

stingrays—the *jiraga* (drone tube) was held up over them at an angle of about 45 degrees and gently *Brr*'d in imitation of a stingray pumping sand and water through its mouth and gills as it lies or swims slowly along the bottom. The natives said that stingrays make a *Brr.* noise when in shallow water. The dance finished on a loud *yeh* shouted by everybody.

The fathers and other men then rubbed sweat (*ungilbilja*) from their armpits and forehead on the mouth and lips of each boy to make their food safe to eat. The old-men Imadoija did this in creation times because they did not want the young ones to die.

Circumcision Rite.

After their evening meal on May 19th the men rested until 9.30 p.m. when they began to paint the *alawadawara* designs on the chests and stomachs of the four initiates. About twenty-five men were seated around and between four fires in the middle of the camp, and the women had their fires in one group about forty yards away. The men wore shorts and shirts, blankets were spread out between the fires, and everyone was in a genial mood. There were two sets of musicians and singers, each with one *jiraga* and three clap-stick players, and up to six men sang under the leadership of one of the old men, one of whom, Baringwa, was particularly good—he sang for long periods in a fine voice, worked up to concert pitch the whole time. These groups moved from one position to another, frequently interchanging players. The initiates were asleep, each in a blanket, but they were awakened, laid on their backs, and without any preliminary rite the painters began their work, as follows:

Tatalara (eagleray and two fish totems) painted Nukinjuba, Gulpidja's son (north-west wind, hammerhead shark and parrot-fish). Banjo is *nunggwaraka* (F, FBr.,MMBr.) to the boy who is *nanukwa.*

Mangogguna (hawk, snake and burramundi) painted Tumanala (whose father is dead but whose totems are eagleray and two fish). Mangogguna is a distant *nepaka* (MFr.Sr.Son or FFSr.Son) to the boy who is *napura* (MFr.Dr.Son).

Mini-mini (south-east wind, *inikabiama* (?) and Tiger Shark) painted Anijuripa, Nebitjura's son (north-west wind, hammerhead shark, and parrot-fish). Mini-mini is *naninga* (FFSr.Son's Son) to the boy who is *naningjaraka.*

Charlie (wallaby, coconut, proa) painted Nejinpapa, Mota's son (south-east wind, *inikabiama,* and Tiger Shark). Charlie is *nunggwaraka* (F, FBr, NMBr.) to the boy who is *nanigunggwaraka* (MMBr.Dr., MMBr. Son's Son).

In some cases the painting was finished by another artist, for example, Mangogguna finished Mini-mini's, which was badly done, and Anawanda finished Tumanala, whom Mangogguna had started. Tatalara, Mangogguna, and Mini-mini all painted the north-west wind (*bara*) design, and Charlie the south-east wind (*mamariga*). They began painting at 10.15 p.m. and finished at 11.30 p.m., during which time the singing and playing increased in intensity and volume.

The songs sung belonged to the cycles of the initiates' totems and those of their guardians. They were rapid in tempo, and the voices high-pitched. All but one of the artists were gentle in handling the boys, talking to them quietly, but Mini-mini pulled and pushed his patient rather roughly. The boys were wrapped in blankets and put to sleep when the painting was finished. While one man painted, one or two others mixed the colours required, and one held a paperbark torch. They painted in the usual way with a feather mid-rib held in the thumb and fore-finger, the stroke being made away from the body, and the other three fingers held in a stiff but graceful curve. Prior to applying the pigment the skin was treated with an orchid juice (*ilmurra*) fixative.

The men slept until they began playing the drone tube (*jiraga*) and clap-sticks, and singing more songs at 5 a.m. A few of the women were seated as before. After an hour of music and songs they woke up the four initiates and laid them in a row on a blanket. One of the boys whimpered, but he was spoken to quietly and reassured. Each one was then stood up in turn, grasped under the armpits by Mangogguna, held around the ankles from behind by a seated man, and whilst Tatalara chanted a song, Mangogguna rocked the initiate backwards and forwards. The seated man represented a big Imadoija, the initiate a young one, Mangogguna a third one, whilst Tatalara sang the related song accompanied by other men. One of the latter leant forward beside Tatalara and played clap-sticks. They sang a wallaby song, and the men uttered numerous *um, um, yeh, ka, wu*: (deep) sounds. Tatalara and Mangogguna then changed places for the second boy, but Imadoija was sung by Tatalara for the other two. They were all ready now for the operation. There was a hush as the men got the boys ready as quickly as possible, one of them being very nervous as to what was going to happen to him.

Naginjimpa cut Nukinjuba, Gulpidja's son; Gulpidja calls Naginjimpa *nanukwaraka* (son).

Naginjimpa cut Mobana's son; the latter calls Naginjimpa *nanukatu-omera*.

Nangapianga cut Nejinpapa, Mota's son; Nangapianga calls Mota, *nungwaraka* (FF or MF).

Nangapianga cut Anijuripa who calls the former *nepaka* (MMB or Fb). Anijuripa and his father, Nebitjura, both call Nangapianga by the term *naningapitjaraka*.

The foreskins were given to the initiate's father, placed in a tin and kept for some time until buried in the bush away from the camp.

While the operation was in progress a bright song was sung with the clapping of hands throughout. The boys' loin-cloth (*naga*) was removed, his penis placed between the operator's fingers and the testicles were pushed back; the operator then pulled out the foreskin and severed it with a safety razor-blade. This was done quickly and efficiently, but two of the boys cried. Immediately after the operation each boy sat up and smelt the sweat of his guardian. This rite protects both the boy and his parents, permits him to eat his food without danger, and safeguards his parents from being speared when in the bush. After this rite, the initiates were stood up and nursed by their fathers. The bleeding was not stopped, nor was the cut cleaned, but large flat leaves from the *amirda* tree were picked, warmed by the fire, and applied to warm the groin and ease the pain. They were also used to wipe away the blood. No attempt was made to keep flies away from the wound until the bleeding stopped, when the boy was covered with a blanket and let go to sleep.

After the tenseness of this period the men relaxed and joked, and some went away to their jobs on the settlement. When we thought everything was finished two men, Nangiljana and Iningarukwa, walked about twenty foot away from the group, both wearing white-cockatoo feather-plumes in their hair. They ran forward for another twenty feet, where Iningarukwa began to wheel around in a forward bent position, and Nangiljana walked around him, with his hands on his companion's back, now and again leaping in the air with his hands up and feet flexed under him, and dragging his feet in a circle which left grooves in the sand. This continued for a few minutes, when two more men, Tungalia and Nangowia, ran along the same path as the first two and began circling around them with their hands on the backs of each other, the whole four wheeling in this manner for some minutes, during which two more men, each carrying a spear-thrower, walked around them, but about ten feet away. The first pair were trevally fish (*kongruna*), the second pair hammerhead

sharks (*munuana*), and the third pair sea-eagles (*iniwakada*). The sharks were chasing the fish, but the latter were caught by the sea-eagles. The whole ceremony then finished abruptly.

The Story of Jundurruna.

In the Aropoia or dream-time, an ancestral being named Jundurruna and his family journeyed from the mouth of the Roper River along the west coast of the Gulf of Carpentaria to Bunmara-kaitja on the northern shore of the Blue Mud Bay, where he made a large waterhole. During this journey to Groote Eylandt, Jundurruna created Bickerton and other islands, including Groote itself. He stayed on Bickerton at a place called Aru-ura, the secret name of which is Banu-pamba, a camp on the east coast marked by two standing stones. They went on to Amalipa, an old ceremonial ground on the shore of Bartalumba Bay, Groote Eylandt, where two more standing stones called Wonidjua mark the site. Here they lived for some time in the caves containing paintings (including a small representation of Jundurruna with his wife under his arm). During this time Jundurruna taught the old men how to dance and sing, and to circumcize initiates. Jundurruna and his family left Amalipa and walked through a valley, formed by a break in the range between Amalipa and Mantalingamadja Point, situated directly north of the ceremonial ground. He went on across the flats, which form most of the northern half of the island, and camped for a little while at an outcrop of rock about halfway across called Numbarilja. Continuing his journey he created Central Hill, known as Jundurruna by the natives, which became his home and the spirit-centre of the stingray, Imadoija, a "big mob" of which live there. He and his family are now represented by large boulders at the totem-centre, Nanbarinja, near this Hill.

There is either some confusion in thought here on the part of my informants or different versions of the legend are in existence. Nangapianga and Turunga told me that two Imadoija men came from the Roper River, sat down at Bickerton Island and then at Amalipa, and journeyed across the flats as above and made Central Hill. Gulpidja, however, said that an Imadoija man came from the same place on the mainland as Jundurruna, with a sawfish (*ingurudungwa*) man who cut out the channel of the Onguruka River with his saw. The Imadoija man followed him, and they met Jundurruna in Lake Hubert. All informants were agreed that these personalities were originally men who are now stingrays and sawfish. Gulpidja, however, depicted fish in his bark painting of the legend (Pl. viii, fig. 7), and fish are portrayed in the caves at Jundurruna to represent the Imadoija and Ingurudungwa. Their journey was apparently at a later date than that of Jundurruna.

Subsequently, two old men Imadoija from Central Hill went down to the east coast of the island, to a sea beach north-east of the Hill, where they made Lake Hubert. One made the eastern shore, the other one made the western shore of the lake. They then followed a track in the sea cut by Ingurudungwa out to a small rocky islet (Liraba) which he also made, where they lived for a long time in the deep water. One of the Imadoija and Ingurudungwa returned to Lake Hubert, where the former is now represented by a prominent sandhill (Mandangopa) on the northern shore.

The other Imadoija was killed by Tumunga-manduma, a man who lived on Liraba, who cut the stingray up into pieces which he cooked and took to a sandhill (called Uraita-madja by Gulpidja and Inuragwatina by Nangapianga and Turunga) on the southern headland of the lake. From this sandhill the view embraces Central Hill and the whole of the lake. Here Tumunga-manduma gave some of the pieces to an old man named Nanunga-gokwa, his wife and children, who ate the food. This family came from the first point south of this sandhill along the coast. Tumunga-manduma took the remaining pieces with him to a place marked by a prominent rock to the south.

Figs. 1-9 represent the series of stone arrangements called Imadoija on the sandhill at Lake Hubert. In Fig. 10 A is Amalipa; B.I., Bickerton Island; O.R., Onguruka River; C.H., Central Hill; L.H., Lake Hubert.

The Stone Arrangement.

On the sandhill Uraita-madja is a stone-arrangement called Imadoija connected with this stingray legend. It consists of nine small heaps of lumps of ironstone, in some of which are from one to four small upright slabs of sandstone or quartzite (Plate viii, and Text-figs. 1-9). There are five flat slabs set in the ground in heap 6, one is set up singly in heap 5, and two in heap 1. The heaps are from 1 foot 6 inches by 2 ft. 6 in. to 2 ft. by 3 ft. 6 in. in area, and up to 1 ft. 5 in. high. They are from 8 to 29 feet apart, and lie on a comparatively flat area now partly overgrown with long grass and scrub. They represent the pieces of Imadoija and those who ate them. One hundred yards to the south-west is a heap of lumps of ironstone and four upright slabs of sandstone which represent Nanunga-gokwa and his family.

Bark Painting.

The bark painting shown (Pl. viii, fig. 7) was made for me by Gulpidja both to portray the story of Jundurruna and Imadoija, and as an example of composition in contrast to the single-figure bark paintings which predominate in collections from this island. From right to left it depicts a rectangle representing the cave painting site at Amalipa where Jundurruna and his family lived; a longer rectangle which is the route of Jundurruna to Central Hill, including the rock, Numbarilja, at which he camped on the way; an oval which is the totem-centre Numbaringa on Central Hill; the swordfish and stingrays, the former cutting out the channel of the Onguruku river followed by the latter.

Acknowledgments.

I have pleasure in expressing my thanks to Mr. F. M. Setzler, Head Curator of Anthropology, United States National Museum, for assistance in recording the stone arrangement, and to Mr. C. P. Mountford who supplied several place names in the legend. This work was carried out in 1948 when I visited Groote Eylandt as a member of the Australian and American Arnhem Land Expedition sponsored by the Commonwealth Government of Australia and the National Geographic Society of America.

Explanation of Plate viii.

1.—General view of the sandhill Uraita-madja. The stones are arranged near the far edge of the white sand area.

2.—Heap 8 showing standing stones.

3-4.—Heaps 3 and 4.

5.—Relationship of several of the heaps.

6.—The separate set of stones representing Nanunga-gokwa and his family. The two taller stones, 2 feet high, are the old man and his wife, and the two shorter ones, 1 foot high, are their two children.

7.—Bark painting made to portray the story of Jundurruna and Imadoija.

THE SNAKE WOMAN, JININGBIRNA

By Frederick D. McCarthy, Dip.Anthr. (Syd.).

Curator of Anthropology, The Australian Museum, Sydney.

(Plate ix; Text-figures 1-11.)

This site was recorded in 1948, when I visited Groote Eylandt as a member of the Australian and American Arnhem Land Expedition, sponsored by the Commonwealth Government of Australia and the National Geographic Society of America.

The Myth.

In the Aropoia or Dreamtime the mythical snake-woman, Jiningbirna with her four children, came up out of a waterhole, Jininga-madja, on McComb's Point, which separates Hemple and Thompson's bays in Port Langdon. Whilst there, a mythical man, Nanatjua, and his companions tried to capture the woman, but she fled northwards along the beach, taking her children with her. When she reached a lake called Ilarago-madja, which is behind the sand-dunes in the middle of Hemple Bay, she found that two of her four children had been lost during the flight. Jiningbirna, not liking the water in this lake, shifted to a pink-quartzite headland further to the north, named after her. Here she tried to camp, but the rock was too hard wherever she started, and she had to dig out many boulders which she threw in heaps on the ground.

In some of the arrangements are narrow path-like strips flanked with stones which represent the pathway she followed along the headland. When she continued her flight she went down the northern side of the headland, forming heaps Nos. 7 and 8 in the same way, until she reached the water's edge, which she followed to the beach of the next bay. She continued along this beach for half a mile, then over the dunes to a large natural depression in the sand, about 180 feet in diameter and 12 feet deep, and almost circular in form, called Aitira. The latter is situated on the western side of a sandy flat with a large shallow billabong to the west and stringybark forest elsewhere. At Aitira, Jiningbirna met Nanatjua, who had walked from Jininga-madja, and agreed to be his wife.

Nanatjua, Jiningbirna and the two children, lived for some time at Aitira, and when they died their bodies were transformed into two flat stones (Pl. ix, fig. 6) in which their spirits still dwell. The burnt stump of a slender curved tree 4 feet high is standing a few feet in front of these stones. Under it is buried in the sand another slab of stone. At certain periods of the year, two members of the Jiningbirna totem will dig up one of the stone slabs. When they do, many snakes, led by a huge red-headed one, come out of the hole. But the two men stroke the head of the leader and talk to him, and after a while he goes back into the hole, taking all the other snakes with him. As soon as this happens, the two men replace the stone, and cover it with sand.

This large red-headed snake, whose specific name was not collected, is dangerous to strangers and will eat them if he can catch them. They are safe, however, if, when they see him coming, they climb a tree. This mythical snake sometimes goes up into the sky. He has several of the attributes of the Rainbow-serpent. It is not known whether the site is connected with rain or other magic, whether it is an increase-centre for snakes and lizards, or whether it is simply a place mentioned in the above legend.

Figs. 1-8 represent the various stone arrangements on Jiningbirna headland.

The Song.

Mr. C. P. Mountford has kindly supplied the following song associated with this site:

Aitira name of depression in ground			jininga-nakwa sacred name of Jiningbirna
nakulanda come along	nijan-muna women walked	naira-tita lost	nijun-undura two children not lost
nuljaka name of totem rock		umbarinja rocks that represent lost children	

This song refers to the time when Jiningbirna and her children travelled to Aitira. Two children were lost, and their bodies are now stones (Text-fig. 6, Pl. ix, fig. 3). The other two children remained with their mother.

The Bark Painting.

(Pl. ix, fig. 7.)

Jiningbirna is shown in the form of a snake. The rectangles projecting from the edge of her body represent the piles of stones that she made on the headland. The larger stone, on the right-hand edge of the painting, is the metamorphosed body of Jiningbirna set up in the sand at Aitira (Pl. ix, fig. 6). The two white figures within the snake are the children of Jiningbirna who were lost. When Iningarukwa painted the story of this legend on a sheet of bark he drew a gecko lizard beside the sand depression called Aitira. This lizard, *ji-tjara,* together with Jiningbirna the snake and *kongruna,* the trevally fish, form his group of three totems.

The Stone-Arrangements.

Jiningbirna headland runs east and west, is rounded on the slopes to the north and south, and the top is undulating from one end to the other. It points towards the entrance to, and commands an extensive view of, Port Langdon. A few widely scattered pandanus and eucalypts are growing on the headland but it is mostly covered with wiry *Triodia* grass between the rocks. I visited the site in May, 1948, with a local native Iningarukwa, and his brother, Nangiljana, the two last surviving members of the totem, from whom the legend was obtained.

The eight arrangements are shown in Text-figures 1-8, in which upright stones are indicated by parallel diagonal lines. The main elements of the arrangements are heaps with a flat, rounded or peaked top; heaps with a depression in the middle, in some of which the flat rock floor is also visible; circles; ovals; lines; standing stones up to 15 inches high.

The following is a description of the various arrangements:

1.—A large, but low heap of small blocks and boulders, in the middle of one end of a large oval rock surface.

2.—A small imperfect circle of stone, occupying a space of 8 x 6 feet, situated on the northern end of an adjacent flat oval rock.

3.—On the same rock surface as No. 2 is another arrangement consisting of several circles of various sizes, and an oval with one side open. The smallest circle has a stone in the middle. This arrangement occupies an area of 10 x 6 feet. There is a jumble of large rocks nearby.

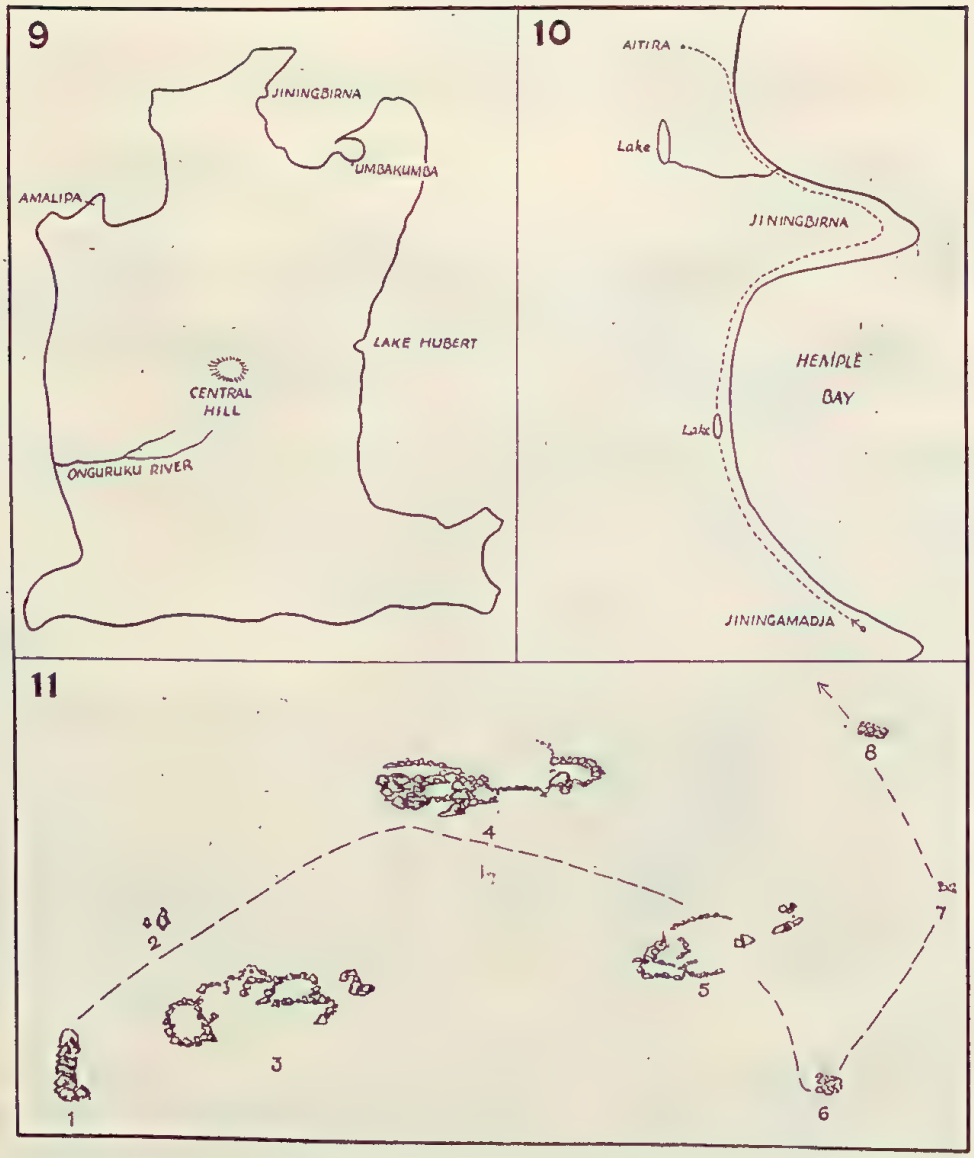

Fig. 9.—Groote Eylandt, showing the location of Jiningbirna headland on the northern shore of Port Langdon.

Fig. 10.—The track of Jiningbirna from Jininga-madja to Aitira.

Fig. 11.—The lay-out of the stone arrangement, and the approximate route followed by Jiningbirna.

4.—A dense assemblage of stones placed on an extensive flat rock. At one end is a large heap containing four clear spaces. It is joined in the middle by a small circle, an oval, and another small circle. At the other end is a heap, clear in the middle, which ends in an angled line of stones. This group is 20 x 10 feet in area.

5.—Situated on the largest flat rock surface on the headland. At one end is a line of stones, with two ovals on one side of it, and what appears to be an imperfect circle on the other side. An ill-arranged line of stones extends along the other side of the group. At the other end are three low heaps of stones. The group occupies an area of 16 x 10 feet.

6.—A single heap of stones, on the edge of the southern side of the headland, carefully packed to a height of 15 inches on a small flat ledge of rock 1 foot thick. A few of the stones have fallen on to the rock surface below. In this heap are the two upright stones, 14 and 18 inches high, which represent the two children lost by

Jiningbirna. They are also shown in Plate ix, fig. 3. Beside this heap is a flat-bottomed depression with an earthen floor in which Jiningbirna once camped (Pl. ix, fig. 4). It is 10 x 8 feet in area, and about 2 feet deep.

7.—A small heap of stones on the northern side of the headland.

8.—A large heap of stones on a small flat rock some distance down the northern side of the headland. It is beside Jiningbirna's track to Aitira.

Explanation of Plate ix.

1-2, 5.—Various parts of arrangement No. 5, showing also the type of rock surface on which the arrangements have been placed.

3.—Heap No. 6, showing the two upright stones which represent Jiningbirna's lost children.

4.—A depression with a flat earthen floor which formed one of Jiningbirna's camps.

6.—The two upright stones at Aitira. The front stone, representing the bodies of the woman, Jiningbirna, and her two children, is 20 inches high, 10 inches wide and an inch thick. The back stone, the body of the man, Nanatjua, is 15 inches high, 9 inches high, and 3 inches thick. The nature of the depression is illustrated.

7.—Bark painting.

THE AUSTRALIAN FRESHWATER PRAWNS OF THE FAMILY ATYIDAE

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(Figures 1-11.)

Very little is known of the Australian freshwater Atyidae. These small prawns are widespread in all the permanent waters, occurring in small waterholes as well as in larger lakes and streams. They generally prefer areas where there is an abundant growth of aquatic plants but are also found in quite open water. Some of the species are found only just above the tidal zone and others where the water is slightly brackish. There are only two major papers on the Australian representatives of this group and these were both published in 1926. Most surprisingly the close appearance of the two has not resulted in any synonymy. Calman (1926) erected a new genus *Caridinides* for a north Queensland species and representatives of three well known genera *Atya, Paratya* and *Caridina* also occur.

The single species of *Atya,* though widespread, is not at all common. These prawns are the largest of the group with a length up to about 55 mm. *Caridana* and the related *Caridinides* are widespread, more in the north, particularly Queensland, where there are six species of *Caridina* in addition to the one species of *Caridinides.* The only species of *Caridina* recorded outside Queensland is *mccullochi* Roux from Pallal, Horton River, New South Wales. *Paratya* is widespread throughout southern Queensland, New South Wales, Victoria, South Australia and Tasmania. In Queensland specimens of this genus have not been collected further north than the Burnett Rver.

Variation is common in most species of this family so that it is often difficult to identify single specimens, particularly if they are juvenile. Ovigerous females are much more readily identified for egg-size is rather constant for a given species, if one bears in mind possible variation due to embryonic development and also to the manner of preservation.

Family Atyidae.

Caridea in which the first two pairs of legs are chelate and similar and only of moderate size. The fingers of the chelae are spooned and tipped with tufts of long hairs.

Genus **Atya** Leach, 1816.

No exopodites on any of the periopods. Second periopods similar to first, with carpus excavated and the palmar portion of the chelae obsolete.

Atya striolata McCulloch & McNeill, 1923.

Atya striolata McCulloch & McNeill, 1923, Rec. Austr. Mus., 14: 55; Roux, 1926, Rec. Austr. Mus., 15: 253.

The series of specimens from Cave Creek, Upper Nerang River, Queensland is described to facilitate comparison with the New South Wales form as described by McCulloch & McNeill.

Size.—43-55 mm. Smallest specimen male; all the remainder (6) females.

Colour.—Dull reddish-brown speckled with microscopic black dots. A broad, almost white, median band extending from the rostrum to the telson and sharply defined by a black border of irregular thickness. Five longitudinal stripes along each side of the carapace, somewhat irregular in outline and bordered in black similar to the median dorsal band. Two similar stripes occur along each side of the abdomen.

Rostrum with four, sometimes five, spines below—the only male specimen shows three. Lower orbital angle forming a sharp projecting spine. Telson with a row of six, sometimes five, movable spinules on each side of the median line. Twenty-five to twenty-eight of the basal joints of the external flagellum of the antennule are much thickened. Merus of third pair of periopods armed with two or three minute spicules on its upper margin. Three, or sometimes two, larger spines form a row on its postero-inferior surface and five or six stout spinules form a crest on the distal portion of its interno-inferior margin. The fourth periopod is similar to the third, but less spinate except that there are two to four, generally four, large spines forming a row on its postero-inferior surface. Fifth periopods with two large spines forming the row on its postero-inferior surface.

Queensland Occurrence.—Cave Creek, Upper Nerang River, almost on the Queensland-New South Wales border (August, 1943, E. F. Riek).

Figures 1-11.

Genus *Paratya*. Lateral view of cephalothorax and first and second periopods X 4 ca. Fig. 1 *Paratya australiensis australiensis* Kemp; Fig. 2 *Paratya australiensis arrostra* nov.; Fig. 3 *Paratya atacta atacta* sp. nov.; Fig. 4 *Paratya atacta adynata* nov.; Fig. 5 *Paratya tasmaniensis* sp. nov.

Genus *Caridina*. Lateral view of cephalothorax and first and second periopods. Only cephalothorax for figure 11 X 4 ca. Fig. 6 *Caridina nilotica meridionalis* Roux; Fig. 7 *Cardinia nilotica aruensis* Roux; Fig. 8 *Caridina indistincta indistincta* Calman; Fig. 9 *Caridina indistincta sobrina* nov.; Fig. 10 *Caridina thermophila* sp. nov.; Fig. 11 *Caridina gracilirostris* de Man.

Distribution.—Nepean River and Woronora River, N.S.W.

The prawns were taken at the overflow of a pool at the base of a small fall. Though the pools below this were carefully searched no prawns could be seen, nor for that matter, could they be found other than just at the overflow of the main pool. The specimens differ slightly from the topotypes examined, the rostrum being thinner and straighter and with sharper spines.

Genus **Paratya** Miers, 1882.

In this genus there is an exopodite on each of the five periopods. Roux (1926) has subdivided the genus into two distinct subgenera on the structure of the carpus of the chelipeds, especially on the second pair.

Subgenus **Paratya** Roux, 1926.

Type of subgenus, *Atyephyra compressa* de Hann.

Carpus of the second chelipeds elongated and but very slightly excavated in front. The digits of the chelipeds provided with long and thin stylets. In the subgenus *Xiphatyoida* the carpus is short and strongly excavated in front.

Only one species has been recognized for the Australian mainland. This was considered a very variable species ranging from the Burnett River in Queensland through New South Wales, Victoria and South Australia to Tasmania.

The size of the egg is rather constant, when compared under the same conditions, and allows a fairly clear separation of the species. As ovigerous females are not always available, other characters are necessary for the ready identification of material and these are supplied by the periopods, particularly the carpus of the first periopods. The rostrum is somewhat variable, but is of some specific value, but there is no close correlation between egg-size and the shape of the rostrum. The Tasmanian species has the smallest eggs which are only half the size of the largest ones at the same stage of development.

Paratya (Paratya) australiensis Kemp, 1917.

(Figure 1.)

Miersa compressa Ortmann, 1894, Jenaische Denkschrift, 8 : 10.

Paratya australiensis Kemp, 1917, Rec. Ind. Mus. Calcutta, 13:303; Calman 1926, Ann. Mag. Nat. Hist., ser. 9, 17:241; Roux 1926, Rec. Austr. Mus., 15:239.

The type locality of this species is Clyde, Sydney, N.S.W., but the specimens described by Kemp were not ovigerous. However, ovigerous females collected from Seven Hills, Sydney, agreeing in all essential characters with the specimens examined by Kemp are described below.

Rostrum extending well beyond the antennular peduncle, gently curved downwards at the base and upward at the tip, slender, its depth about one-ninth of its length, twenty to thirty-two spinules above, of which one to three are behind the orbit, the distal ones extending almost or quite to the tip and with from five to nine teeth below but generally with not more than seven. Stylocerite reaching to the proximal end of the second antennular segment, distal spine of first segment quite short and blunt. Antennal scale a little longer than the antennular peduncle. Carpus of the first chelipeds about three times as long as wide, and shorter than the chela, which has the fingers longer than the palm. Carpus of the second chelipeds about six times as long as wide, very much longer than the chela, which has the fingers longer than the

palm. Dactylus of third and fourth periopods one-fifth of propodus, with ten or eleven, rarely nine or twelve, evenly graduated spines; that of fifth periopods one-fourth of propodus with seventy or more spines. Telson with three pairs of dorsal spinules (including the subterminal pair) and with six terminal plumose spines, of which the outer pair are the strongest, but the median pair the longest. Eggs small and numerous, length 0.75-0.80 mm. Length ovigerous female, 33 mm.

Type locality.—Clyde, Sydney.

Distribution.—Seven Hills, Sydney, N.S.W. The specimens from Norton's Basin, Nepean River; Marrickville and Middle Harbour, Sydney, and from Jamberoo described by Roux (1926) probably belong to this species.

The specimens of this species can be separated readily from those of *P. atacta adynata,* also from the Sydney region, on the size of the egg and the shape of the rostrum.

Paratya australiensis arrostra, nov.

(Figure 2.)

Rostrum short, straight, not reaching the distal end of the antennular peduncle, eighteen to twenty-four spinules on its upper surface of which from one to three are behind the orbit and with from three to eight below but generally with four. Stylocerite and antennal scale as in typical form. Carpus of first cheliped stouter and more deeply excavate on the anterior border than in the typical form. There are fewer spines (65) on the dactylus of the fifth periopods and only seven or eight on the third and fourth. Eggs of much the same size as in the typical form, but a little smaller, 0.70 to 0.75 mm. in length. Length ovigerous female, 35 mm.

Type.—Holotype ovigerous female and paratypes in the Australian Museum, Sydney.

Type locality.—Terrors Creek, Dayboro, Queensland. (8th August, 1942, E. F. Riek).

Distribution.—Running Creek, Queensland-N.S.W. border; Mary River, Conondale; Enoggera Reservoir; Cedar Creek, Tambourine; Cotter River, A.C.T.; Crookwell, N.S.W.; Fitzroy Falls, N.S.W.

Ortmann's specimens from the Burnett River, Queensland, probably belong to this subspecies as, too, do some of the specimens from North Yanco, Narrandera, described by Roux (1926:241) and those by Calman (1926) from the St. George District, Queensland.

This subspecies differs from the typical form in the shape of the rostrum and of the carpus of the first cheliped.

Paratya atacta, sp. nov.

(Figure 3.)

Rostrum somewhat variable, in some cases extending well beyond the antennular peduncle, jutting more or less straight out without obvious sign of dorsal curvature. The slenderness of the rostrum depends largely on its proportionate length. There is considerable variation in the number of spinules of the rostrum. There are twenty-one to thirty spinules above, of which one to three are behind the orbit, the distal ones extending nearly or quite to the tip and with from five to sixteen below but generally less than ten. Stylocerite reaching at least as far as, but not quite to the middle of, the second antennular segment and the distal spine of the first segment extending over the proximal third of the second segment. Antennal scale a

little longer than the antennular peduncle. Carpus of first chelipeds only about two times as long as wide, very deeply excavate and shorter than the chela, which has the fingers slightly shorter than the palm. Carpus of second chelipeds about five times as long as wide, considerably longer than the chela, which has the fingers equal to the palm. Dactylus of third and fourth periopods one-fifth of propodus, with eight to ten graduated spines; that of fifth periopods one-fourth to one-fifth of the propodus, with about fifty-nine fine spines. Telson with three pairs of dorsal spinules (including subterminal pair) and six (or seven) plumose spines of which the median ones are the longest. Eggs large, length 0.89 to 0.97 mm. Length ovigerous female, 36 mm.

Type.—Holotype ovigerous female and paratypes in the Australian Museum, Sydney.

Type locality.—Upper Nerang River; south Queensland (20th August, 1943, E. F. Riek).

Distribution.—Waraba Creek, Caboolture; Conondale; Lamington National Park.

The rostral structure is very similar to that of *australiensis arrostra,* but the two can be separated readily on the structure of the first and second periopods and on egg size.

Paratya atacta adynata, nov.

(Figure 4.)

Rostrum short, not reaching to the distal ends of the antennular peduncle and of rather stout shape. Fewer spinules on the rostrum than in the typical form—fifteen to thirty above, of which 0 to four are behind the orbit and three to eight below but generally with five or six. Stylocerite slightly shorter, often not quite reaching proximal end of second segment of antennular peduncle. Carpus of first periopod not quite as stout as in the typical form. Dactyli of third and fourth periopods with eight or nine spines, that of fifth periopod with about forty-eight spines. Eggs of much the same size as in the typical form. Length ovigerous female 34 mm.

Type.—Holotype ovigerous female and paratypes in the Australian Museum, Sydney.

Type locality.—Small Creek in upper reaches of Middle Harbour, Sydney, N.S.W. (17th December, 1944, E. F. Riek).

This subspecies can be distinguished on the shape of the rostrum with its fewer spinules. The series of specimens described above differs strikingly from that described by Roux (1926) from the same area, but it is similar to that from Parramatta described in the same paper. It is rather peculiar that specimens collected from Seven Hills close to Parramatta should have differed from those described by Roux from Parramatta and have been similar to those described as from Middle Harbour. It would seem that the labels of the material examined by Roux have become interchanged or that the two species of the Sydney area have a similar distribution.

Paratya tasmaniensis, sp. nov.

(Figure 5.)

Rostrum extending well beyond the antennular peduncle and slightly beyond the antennal scale, gently curved downwards near its base and upwards at the tip, slender, its depth about one-seventh of its length, twenty to twenty-four spicules above, of which normally three lie behind the orbit, the distal spicules extending almost or quite to the tip and with seven to fourteen spicules below, but generally less than

ten. Stylocerite reaching only to the proximal end of the second antennular segment, distal spine of first segment quite short and blunt. Carpus of first chelipeds about twice as long as greatest width, slightly shorter than the chela, which has the fingers shorter than the palm. Carpus of second chelipeds about seven times as long as wide, very much longer than the chela which has the fingers longer than the palm. Dactyli of third and fourth periopods about one-fifth of propodus, with six or seven evenly graduated spines, that of the fifth periopods one-fourth of propodus with sixty or more spines. Telson with three pairs of dorsal spinules (including the subterminal pair) and with six terminal plumose spines of which the median are the longest. Eggs relatively very small, about 0.52 mm. long. Length ovigerous female 35 mm.

Types.—Holotype ovigerous female and paratypes in the Australian Museum, Sydney.

Type Locality.—Small stream at Kingston, Tasmania, just above the tidal zone. (10th January, 1947, E. F. Riek.)

Distribution.—Non-ovigerous specimens from the Clyde River at Bothwell, Tasmania, and from the Prosser River at Orford, Tasmania, are considered to belong to this species. The rostrum is somewhat shorter and straighter than in the type series.

The species has a rostrum similar to that of *australiensis* but differs in the shorter carpus of the first periopods and spines of the dactyli as well as in the quite different egg-size.

Genus **Caridinides** Calman, 1926.

Genotype, *Caridinides wilkinsi* Calman, 1926.

Resembling *Caridina*, but having a well-developed exopod on the first pair of chelipeds. No supraorbital spine. Chelipeds of the Caridina-type, carpus of the first pair slightly excavated. An arthrobranch at the base of the first periopods (nine pairs of gills). A number of spines on the exopod of the uropods.

Caridinides wilkinsi Calman, 1926.

Caridinides wilkinsi Calman, 1926, Ann. Mag. Nat. Hist., (9) 17: 242.

With the characters of the genus, which is monotypic.

Type Locality.—Olive River, Temple Bay, east coast of Cape York Peninsula.

Remarks.—The species has been collected only from slightly brackish water very close to the sea.

Genus **Caridina** Milne-Edwards, 1837.

No expodite on any of the periopods. Palmar portion of the chelae distinct and well developed. No supraorbital spine. An arthrobranch at the base of the first periopods (nine pairs of gills). A number of spines on the exopod of the uropod.

There is quite extreme variation of the egg-size in the Australian species. For *serratirostris* the length is recorded as about 0.28 mm.; in *nilotica meridionalis* they are about 0.40 mm.; in *mccullochi* about 0.50 mm.; in *nilotica aruensis* about 0.65 mm.; in *indistincta indistincta* about 0.85 mm. to 0.95 mm. and the same for *thermophila*. The subspecies *indistincta sobrina* from Fraser Island has the largest eggs measuring up to 1.2 mm. In some samples from Fraser Island the eggs are no larger than the largest recorded for the typical form. Although the eggs in *thermophila* are of a size similar to those of *indistincta* the rostrum is quite distinct and the apical spines of the telson even more so.

The habitat of *thermophila* is quite remarkable. The specimens were taken from an artesian bore drain where they were simply swarming. The water emerging from the ground was too hot for normal life but after flowing for some distance it had cooled sufficiently to support life. The prawns were most abundant where the water was still too hot for comfortable wading. Only two of the many specimens collected were ovigerous, but the material was obtained in May and so rather too early for one to expect eggs, but it seems most likely that the species breeds in this hot water. A study of the distribution of this species would be most interesting for bores are arificial and of recent origin and not a high percentage are so hot. The eyes are well developed so the species is unlikely to be subterranean. Time did not permit a study of its distribution down the bore drain to the really cold waters but there was a decrease in the concentration of specimens as one proceeded downstream.

Caridina typa Milne-Edwards, 1837.

Caridina typa Roux, 1926, Rec. Austr. Mus., 15: 246.

The rostrum is distinctive; in some individuals it reaches as far as the end of the basal segment of the antennular peduncle; in others it is slightly longer; in all specimens it is bent downwards and the upper border is devoid of teeth; the lower border has two to five teeth. The antennular bridge has a low but distinct carina. The epipodites are well developed at the base of the four anterior pairs of periopods. Length 24-25 mm.

Distribution.—In Queensland the species is recorded from Cooktown and from Dunk Island by Roux. No additional material has been examined.

Caridina serratirostris de Man, 1892.

Caridina serratirostris de Man, 1892, Zool. Ergebn. Reise Nierld. Ind. II, 1892: 382; Roux, 1926, Rec. Austr. Mus., 15: 248.

Roux records this species from three poorly preserved specimens collected at Cairns. Additional material has not been examined.

The rostrum begins before the middle of the carapace and is turned downwards; it reaches hardly to the extremity of the second antennular segment. It is about five to six times as long as broad, and has on the upper border nineteen teeth, the proximal five or six of which are situated on the cephalothorax. On the inferior border there are three to six teeth. The eggs are small and numerous, they are 0.28 to 0.36 mm. long and 0.19 to 0.21 mm. broad; epipodites are present at the base of the four anterior pairs of periopods.

Distribution.—Cairns, Queensland.

The species occurred in association with *C. nilotica meridionalis* Roux.

Caridina nilotica meridionalis Roux, 1926.

(Figure 6.)

Caridina wycki Ortmann, 1894, in Semons Zool. Forschungar Austr., 5: 11.

Caridina nilotica var. *meridionalis* Roux, 1926, Nova Caledonia, Zoologie, 4, (2): 207; Roux 1926, Rec. Austr. Mus., 15: 246.

Antennular bridge without keel, preorbital length of antennular peduncle being 0.8 mm. from the postorbital length of the cephalothorax. Rostrum mostly without teeth on the distal part of the upper border (one-third). This upper border has sixteen to twenty-two teeth, the first two of which are situated on the cephalothorax. On the

lower border there are thirteen to sixteen teeth, the distal ones of which are often very small. In these specimens the rostrum is very long; it reaches beyond the end of the antennular peduncle, and its extremity, turned upwards, reaches to the end of the scaphocerite. Carpus of the first periopod short, its breadth not quite half its length, shorter than the chela; second carpus somewhat longer than the chela, up to one and a half times. Uropodal spines ten to fifteen. Telson normally ending in a slight median projection and with three pairs of spines, of which the outer one is the longest, in addition to the pair of small subterminal spines. The eggs are small and numerous, being 0.36-0.39 mm. long and 0.21-0.23 mm. broad, though sometimes a little larger.

Distribution.—The subspecies was described originally from New Caledonia. Queensland distribution: Creek at Cooktown; Cairns; Eidsvold; Burnett River.

New Distribution Records.—Cairns; Black River; Townsville; George Creek, between Coen and Annie River.

Caridina nilotica aruensis Roux, 1919.
(Figure 7.)

Caridina nilotica var. *aruensis* Roux, 1919, Abhandl, Senckenb. Gesell. Frankfurt, 35: 321; Roux, 1926, Rec. Austr. Mus., 15: 248.

The rostrum has the typical form and reaches to the end of the scaphocerite; its distal part is slightly turned upwards. The upper border bears a proximal series of twenty-one to twenty-three teeth, the first two or three of which are situated on the carapace. One or two apical teeth are separated from the long proximal series by a short space devoid of teeth. The lower border carries nine to fourteen teeth. Carpus of first periopod short, not half as wide as long, shorter than chela; second carpus from one and a quarter to one and a half times as long as chela. Uropodal spines ten to twelve. Telson normal, as in *meridionalis* but the median projection smaller. The eggs are few in number and rather large. They are 0.64 mm. long and 0.39 mm. broad; very different in size from those of the preceding subspecies of the same species.

Distribution.—Aru Islands. Queensland distribution.—40 miles S.W. of Townsville.

New Distribution Records.—Charters Towers; Burdekin River, Macrossan; Townsville; Mary River at Conondale.

Caridina mccullochi Roux, 1926.

Caridina mccullochi Roux, 1926, Rec. Austr. Mus., 15: 249.

Antennular bridge devoid of a keel. Rostrum rather long, generally reaching to the end of the scaphocerite or a little longer, at first slightly bent downwards before the orbit and afterwards directed horizontally, length seven times the breadth, upper border carrying numerous teeth which occupy the whole length, but vary in size, proximal series comprises small, regularly spaced teeth while the distal ones are bigger, more inclined, and further separated from one another. Teeth above vary from twenty-five to thirty-two, the first three of which are situated on the cephalothorax and the next twenty-two to twenty-five form the proximal series; the distal teeth vary in number. The lower border has seven to ten teeth.

Carpus of first periopod relatively long, distal excavation shallow, chela a little longer than the carpus. Carpus of second periopods more elongated, about six times as long as greatest width. Dactyli of third and fourth periopods with nine to ten spines, the terminal one included, the fifth with fifty-five to fifty-seven spines. Uropodal spines twelve to fourteen. Telson ending in four pairs of spines of the same length. Eggs small and numerous, about 0.50 mm. long.

Types.—In the Australian Museum, Sydney.

Type Locality.—Pallal, Horton River, near Bingara, N.S.W. (A.R. McCulloch, 1909).

Roux also records the species from Port Macquarie and from North Yanco, Narrandera, N.S.W.

The species is recognizable at once on the peculiar rostral structure where the distal spines of the upper surface are larger than the more basal ones.

Caridina indistincta Calman, 1926.

(Figure 8.)

Caridina indistincta Calman, 1926, Ann. Mag. Nat. Hist., (9) 17: 244.

Rostrum extending slightly beyond the antennular peduncle, gently curved downwards at the base and upwards at the tip, slender, its depth not more than one-eighth of its length; twenty to thirty-two spinules above, of which one to four are behind the orbit, the distal ones extending almost or quite to the tip, and four to eight teeth below. Stylocerite reaching about the middle of the first antennular segment, distal spine not reaching the middle of second, which is not quite two-thirds of the first, third segment more than half as long as second. Antennular scale about equal to rostrum; angle of second segment spiniform. Carpus of first chelipeds about three times as long as wide, and shorter than the chela, which has the fingers longer than the palm. Carpus of second chelipeds about five to six times as long as wide, longer by one-quarter than the chela, which has the fingers longer than the palm. Dactylus of third and fourth periopods less than one-third of propodus, with nine to thirteen, usually ten, evenly graduated spines; that of fifth periopods one-third of propodus, with thirty-seven to forty-three spines. Merus of third and fourth pairs with three spines, that of fifth with two. Uropodal spines nine to eleven. Telson with five or six pairs of dorsal spinules (including subterminal pair) and with six terminal spines, of which the outer pair are longer and stronger than the others. Telson medianly produced into a distinct projection between the terminal spines. Eggs very large and relatively few in number, length varying from 0.85 to 0.95 mm. Length ovigerous female 30 mm.

Type Locality.—St. George District, Queensland.

Distribution.—Widespread in south Queensland localities including Brisbane, Moreton Island, Caloundra, Caboolture, Rosewood and Conondale.

The species was described originally from a series of eight specimens collected in bore drainwater, but has since been found in isolated ponds and creeks.

At Brisbane ovigerous females are taken from the end of August to the end of November or early December, those of August, September and October often being freshly laid. During other months of the year ovigerous females have not been collected except for a single specimen in May which occurred with abundant non-ovigerous specimens.

One normally collects very juvenile specimens in November with increasing size in December. These seem to become about half grown by the winter though there may be some smaller specimens. The species seems to take two years to reach maturity but this has not been confirmed by breeding.

Caridina indistincta sobrina, nov.

(Figure 9.)

This subspecies differs from the typical form in the shape and structure of the periopods. Carpus of first periopods more excavate. Dactylus of third and fourth

periopods with seven to ten spines, that of the fifth with from twenty to thirty-two. Telson with four or five pairs of dorsal spinules and with six terminal spines, but the telson only very slightly produced medianly and the middle spines rather short. Eggs somewhat larger than in the typical form, length 0.95 to 1.2 mm. Length ovigerous female 16-20 mm.

Types.—Holotype ovigerous female and paratypes in the Australian Museum, Sydney.

Type Locality.—Rocky Creek, Fraser Island, Queensland (August, 1941, E. F. Riek).

Distribution.—Lakes and streams of Fraser Island.

The subspecies can be distinguished by the somewhat larger eggs and the fewer spines on the dactyli of the legs.

Caridina thermophila, sp. nov.

(Figure 10.)

The rostrum is comparatively short, hardly reaching to the extremity of the antennular peduncle. It is about five to six times as long as broad, and has on the upper border twenty to twenty-four teeth of which the first one to four are situated behind the orbit. Spines decrease in size towards the apex and there become widely spaced so that the apex appears more or less without spines. On the lower border there are four to six teeth. Carpus of first periopods not two times as long as wide and shorter than the chela, which has the fingers longer than the palm. Carpus of second cheliped about four to five times as long as wide, only about one and a quarter times as long as chela. Dactylus of third and fourth periopods less than one-third of propodus and with from eight to eleven spines, that of fifth periopods one-third of propodus and with from forty-five to forty-nine spines. Merus of third and fourth pairs with three spines, that of fifth with two or three. Uropodal spines fifteen to seventeen. Telson with five or six pairs of dorsal spinules (including subterminal pair), and with eight terminal spines of which the median are the largest with the rest decreasing in size laterally. Epipodites well developed at the base of the four anterior pairs of periopods. Eggs large and very few in number. The two ovigerous females examined each had only from about twelve to twenty eggs; length 0.85 mm., breadth 0.53 mm. Length ovigerous female 15 mm.

Types.—Holotype ovigerous female and paratypes in the Australian Museum, Sydney.

Type Locality.—Muttaburra, western Queensland (27th May, 1945, E. F. Riek).

Distribution.—The species is known only from the type locality.

The extensive series of specimens described above was collected from a bore drain where the water was quite hot and unpleasant to stand in for any considerable time.

There is one very interesting specimen in this series. In this example the first periopod of the left side is provided with an exopodite whereas the right side is without one. This condition approaches that which is normal for the genus *Caridinides* where both first periopods are provided with exopodites.

This species differs from *indistincta* in its much smaller size and quite different structure of the rostrum, with the apex above devoid of spines and below with only a few spines. In *indistincta* the spines above occur right to the apex and there are many below. The terminal spines of the telson are very different and the uropodal spines in *thermophila* are more numerous than usual.

Caridina gracilirostris de Man, 1892.

(Figure 11.)

Caridina gracilirostris de Man, 1892, Zool. Ergebn., 2:399; Blanco 1935, Philipp. Journ. Sci., 56:32.

A single mature specimen from Cairns is described. Rostrum extremely long, extending at least as far again as the antennal scale; upper margin armed with eight large, widely spaced spines over the basal half, apical half without spines except for the sub-apical one; lower margin with a complete series of twenty-seven spines decreasing gradually in size towards the apex where there is a slight break before the subterminal spine.

Carpus of first periopod one and three-quarter times as long as wide, much shorter than chela, second carpus only very slightly longer than chela, about four times as long as wide. Dactyli of third and fourth periopods with seven spines and fifth with about thirty-five spines. Uropods each with seven to nine spines. Telson with four terminal spines, in addition to the subterminal pair, with the inner spines smaller than the outer. Length of specimen, 35 mm.

This is the first record of this Asiatic species from Australia. There is a single specimen taken from a tidal creek at Cairns, north Queensland (15th August, 1942, I.S.R. Munro). The species was taken associated with *Caridina nilotica meridionalis* Roux.

The species cannot be confused with any other species recorded from Australia because of the very large rostrum but also because of the shortened second carpus.

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FISHES COLLECTED BY THE AUSTRALIAN MUSEUM EXPEDITION, 1952.

By Gilbert P. Whitley, F.R.Z.S.
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(Figures 1-4.)

The fifty-four specimens of fishes brought back by the Australian Museum Expedition belong to eight families or ten species of shore-inhabiting kinds such as are found in tropical mangrove-swamps or else in freshwater rivers. There are no coral-reef or open marine forms because the main activities of the expedition were concerned with geology and terrestial fauna. The Palmer or "Barramundi", *Lates calcarifer* (Bloch, 1790), was photographed at the Forrest River (Keast, Austn. Mus. Mag., xi, 1953, pp. 4, 9-10, fig.) but no specimen was preserved.

In the interior of Australia, drought conditions were encountered, so specimens could only be obtained from three localities: Wilson River and Forrest River in the Kimberley Division of Western Australia and at Port Keats in the Northern Territory. Previously the Australian Museum had no fishes from any of these places, so they are of zoogeographical interest. The range of several freshwater fishes (chanda perch, and gudgeon) and of two estuarine mudskippers can be extended into Western Australia for the first time as a result of this expedition's work. The freshwater fishes all belong to the Leichhardtian fluvifaunula which embraces the rivers of southern New Guinea and Papua, north-western Queensland, the Northern Territory and north-western Australia, which seem to share the same species of fishes and other aquatic animals.

Some difficulty has been experienced in identifying the specimens because types of so many Australian species are in overseas museums. The enterprise of early French, Scandinavian and other naturalists in collecting specimens in remote Australian areas many years ago was most praiseworthy, but it remains for possibly easier and quicker global travel in the future to enable the critical modern taxonomist to compare all the specimens he would like to see, unless television can some day be utilized for that purpose. In this collection of only ten species, it is noteworthy that the typical specimens of seven, if they still exist, are probably in Paris, London, Oslo, Leyden and Berlin; the types of only two of the species are in Australia, and those of two others desirable for comparison are in Amsterdam and Vienna. Reliance has therefore been placed on descriptions in the scattered literature quoted under each species. Illustrations are supplied of all hitherto unfigured kinds. One species collected appears to be new, and the opportunity is taken to describe another not encountered by the expedition.

Family Mugilidae.

Genus **Ellochelon** Whitley, 1930.

Ellochelon Whitley, Austr. Zool. vi, 1930, 251. Orthotype, *Mugil vaigiensis* Quoy and Gaimard.

Ellochelon vaigiensis (Quoy and Gaimard).

Mugil vaigiensis Quoy and Gaimard, Voy. Uranie Physic., Zool., 1825, 337, Pl. lix, fig. 2. Waigiou, New Guinea.

Austr. Mus. Exped. material.—One immature specimen 149 mm. in standard length or nearly 7½ inches overall. Austr. Mus. Regd. No. IB. 2841.: Field No. 599.

Locality.—West Headland, Port Keats, Northern Territory, 23 June, 1952.

Family Melanotaeniidae.

Genus **Melanotaenia** Gill, 1863.

Melanotaenia nigrans (Richardson).

Atherina nigrans Richardson, Ann. Mag. Nat. Hist., xi, 1843, 180. King's River, Port Essington, Northern Territory.

Melanotaenia nigrans McCulloch, Austr. Mus. Mem., v, 1929, 112 (synonymy).

Austr. Mus. Exped. material.—Sixteen specimens, about 17 to 40 mm. in total length, mostly about 26 to 27 mm. (Austr. Mus. Regd. Nos. IB.2828 to 2830, Field No. 201, part) from the Wilson River, 106 miles south of Wyndham, Western Australia.

Family Apogonidae.

Genus **Apogon** Lacépède, 1802.

Subgenus **Pristiapogon** Klunzinger, 1870.

Apogon (Pristiapogon) ruppelli Gunther.

Apogon ruppelli Gunther, Cat. Fish. Brit. Mus. i, 1859, 236, "Victoria", *i.e.*, Victoria River, Northern Territory (H.M.S. "Herald"); Klunzinger, Sitzb. Akad. Wiss. Wien., lxxx, 1, 1879, 344; Ogilby, Proc. Linn. Soc. N.S.Wales, xxiv, 1899, 165; Waite, Rec. Austr. Mus., iv, 1902, 181, Pl. xxvii; Alexander, Journ. Linn. Soc. London, Zool., xxxiv, 1922, 481; Paradice and Whitley, Mem. Qld. Mus., ix, 1927, 84 and 97; Serventy, The Emu, xxxviii, 1938, 288 *et seq.* and 359; Marshall, Mem. Qld. Mus., xii, 1941, p. 56; and of Australian lists.

D. vii/i; 10; A. ii, 9; L. Lat. 25 to hypural joint. Tr. 2/1/6. Three predorsal scales. Teeth in villiform bands. Preopercular limbs serrate. Dorsals separate.

Yellow to brownish. An oblique dark grey bar from eye to preopercular angle. 7 dark spots along l. lat. One each at end of dorsal and anal fins. A larger blackish spot before caudal root.

One specimen, 46 mm. in standard length and 2.35 in. in total length. Austr. Mus. Regd. No. IB 2842. Field No. 600, part.

Locality.—West Headland, Port Keats; 23 June, 1952.

Family Chandidae.

Genus **Blandowskiella** Iredale & Whitley, 1932.

Blandowskiella Iredale and Whitley, Victorian Naturalist, xlix, August, 1932, p. 95. Orthotype, *Pseudoambassis castelnaui* Macleay.

Blandowskiella dalyensis (Rendahl).

(Figure 1.)

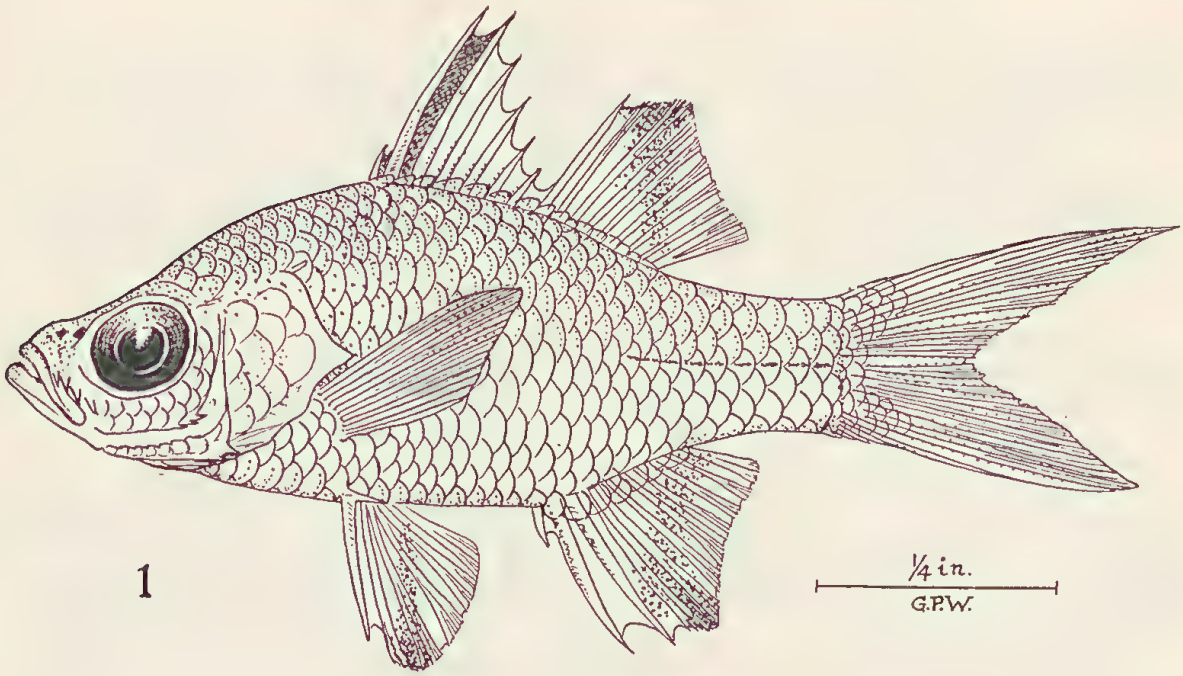
Ambassis dalyensis Rendahl, Medd. Zool. Mus. Kristiania, No. 5, Sept., 1922, p. 187. Daly River, Northern Territory. Type in Royal Zool. Mus. Oslo.

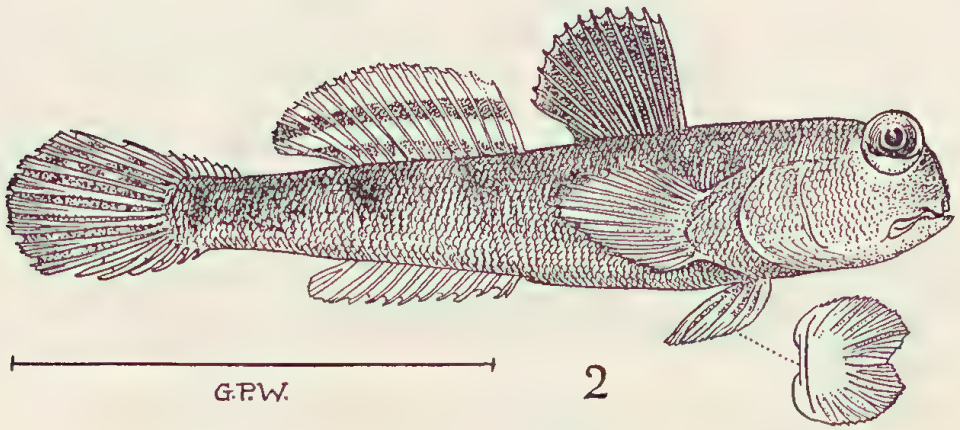
Sixteen small specimens, 15 to 30 mm. in total length, mostly between 15 and 20 mm. Austr. Mus. Regd. Nos. IB 2831 to 2833; Field No. 201, part.

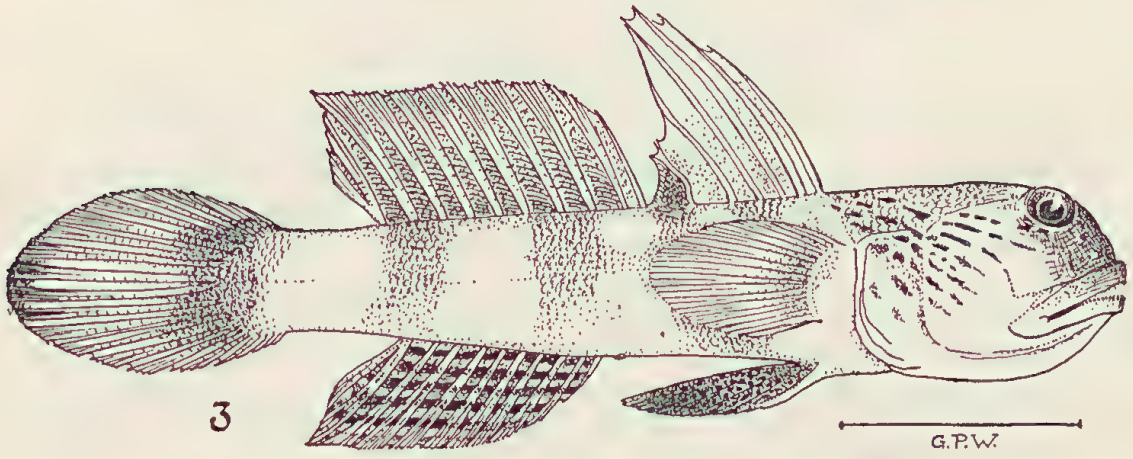
Locality.—Wilson River, 106 miles south of Wyndham, Western Australia, 20 May, 1952. New record for Western Australia and not hitherto figured so a description and illustration of the largest specimen are here presented.

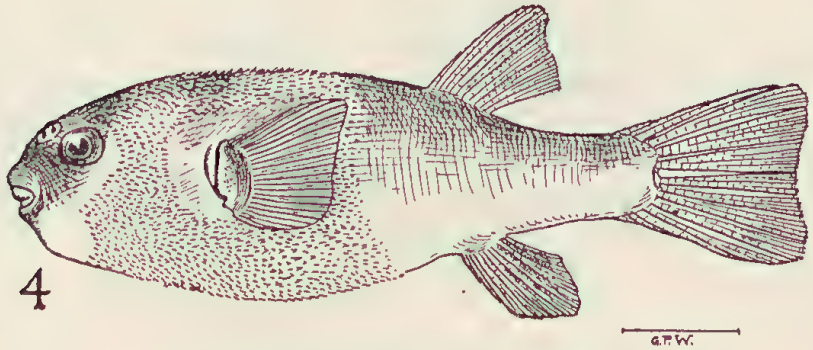
D. vii, i, 8 (9) A. iii, 8; P. *c.* 12; V. i, 5; C. 15 branched rays. L. lat. l. Sc. *circa* 25. Tr. and predorsal scales about 12.

Head (9 mm.) 2.4, height of body (8) 2.7 in standard length (22). Eye (3) 3 in head, 1.3 in postorbital part of head (4) and 1.4 length of interorbital space (2.2)









For explanation of figures see page 131.

which equals snout. Second and third dorsal spines longest (little more than 5 mm.) and equal, thus less than three-tenths of standard length. In the anal fin the third spine is the longest, 5 mm., and nearly as long as longest dorsal spines.

Profile concave over eyes. Maxillary rounded, reaching below eye. Fine teeth on jaws. Three to five preorbital serrae. Both limbs of preopercle serrated, 3 to 5 serrae on either side, thus fewer than in typical *dalyensis*, but probably this is due to immaturity and smaller size; the serrae are not even bilaterally symmetrical. Lower angle of gill-cover with 2 to 5 spines. Two rows of scales below eye.

Lateral line tubes developed anteriorly on only one scale on each side on the fifth row. The following scales have no tubes and their edges are convex, not bilobed. Nor are there tubes or lobes on the posterior scales on the middle of each side.

Recumbent dorsal spine concealed. General facies as figured.

Colour in alcohol pale yellowish-brown. Top of head and margins of scales sparsely punctulated. A thin, broken dark-bluish stripe along middle of each side posteriorly. Fins mostly transparent or punctulate, particularly towards tips of second dorsal, anal and ventrals. Membrane between second and third dorsal spines nearly black.

The specimen agrees well with Rendahl's account, differing only in the number of scales (incomplete in Rendahl's type), lengths of dorsal and anal spines, and fewer serrae on head, but these are doubtless due to growth-differences. The curious variation of the lateral line scales is covered by the disparities shown by Rendahl's paratypes.

Ambassis mulleri Klunzinger (Sitzungsb. K. Akad. Wiss Wien., lxxx, 1879, 346, Pl. i, fig. 3, from Port Darwin) has 9 anal rays, 25 scales along body, preorbital not serrated, and dorsal membrane hyaline.

Blandowskiella dalyensis may also be recorded from Queensland for the first time, as I have identified more than eighty specimens in The Australian Museum and in Mr. Melbourne Ward's Gallery from the following localities in the Northern Territory and Queensland:

(1) Baker's Jungle, Northern Territory. Received from J. D. Ogilby. Austr. Mus. Regd. No. I. 13633. Associated with *Melanotaenia nigrans.*

(2) Banker's Jungle Creek, Koolpinyah Station, about 30 miles inland from Darwin, N.T. Mr. Melbourne Ward. Nos. IA. 7722 to 7725. Associated with *Melanotaenia nigrans* and *Mogurnda mogurnda.*

(3) Caught close to Cape Stewart in north central Arnhem Land, N.T., by natives on the flooded coastal plains. Dr. D. Thomson. Nos. IB 2029 to 2034. Associated with *Denariusa bandata,* a related genus.

(4) Wenlock Downs Station, Batavia River, Queensland. Mr. Stanley Boyd per Mr. M. Ward. Nos. IB. 721 to 722. Associated with *Melanotaenia nigrans, Mogurnda mogurnda,* and *Neosilurus mortoni.*

(5) Hot Springs, North Queensland. Mr. L. Grant. Specimens in Mr. M. Ward's Gallery, Blue Mountains. Associated with *Melanotaenia nigrans, Craterocephalus stercus-muscarum,* and *Mogurnda mogurnda.*

Family Eleotridae.

Genus **Oxyeleotris** Bleeker, 1874.

Oxyeleotris herwerdeni (Weber).

Eleotris herwerdenii Weber, Notes Leyden Mus., xxxii, Dec. 1910, 238, Lorentz River, New Guinea. Figured in Nova Guinea, ix, 1913, 594, Pl. xiii, fig. 2 and xiv, fig. 2.

One specimen, rather shrivelled, is tentatively identified as this species. As *Eleotris herwerdenii* it was first noticed from Australia by Koumans (Zool. Meded., xx, 1937, 25) thus; "2 sp. Katherine riv. N.. Australia. Prof. Handschin 1932." The Australian Museum's Expedition specimen is Regd. No. IB. 2834. Field No. 206.

Locality.—Wilson River, 106 miles south of Wyndham, Western Australia; 20 May 1952. New record for Western Australia.

Family Periophthalmidae.

Genus **Euchoristopus** Gill, 1863.

Euchoristopus kalolo (Lesson).

Periophthalmus kalolo Lesson, Voy. Coquille, Zool. ii, 1, 1831, 146. Waigiou, New Guinea.

Periophthalmus argentilineatus Cuvier and Valenciennes, Hist. Nat. Poiss., xii, 1837, 191. Waigiou; Harms, Zeit. Wiss. Zool., cxxxiii, 1929, 243, Pls. vi-vii and text-figs. 19 *et seq.*; Eggert, *ibid,* pp. 400 and 404, Pls. viii-ix; McCulloch and Ogilby, Rec. Austr. Mus., xii, 10, 1919, 194 (Pl. xxxi, fig. 1, represents subspecies *regius*).

Periophthalmus koelreuteri Rendahl, Medd. Zool. Mus. Kristiania v, 1922, 165 and 191. Not *Gobius koelreuteri* Pallas, Spic. Zool. viii, 1770, 8, Pl. ii, figs. 1-3 from no locality (probably West Africa).

Euchoristopus kalolo & subsp. *regius* Whitley, Austr. Zool., vi, 1931, 325 and 326.

Periophthalmus vulgaris Eggert, Zool Jahrb., lxvii, 1935, 35, 43, 80 *et seq.*; Pls. vi-vii, figs. 23-30. Batavia, *ex* Schöttle, Zeit. Wiss. Zool., cxl, 1931, 73.

Austr. Mus. Exped. material.—Five specimens, up to 1.9 in. long from Port Keats mission, Northern Territory; 26 June 1952. Austr. Mus. Regd. Nos. IB. 2845, 2846, and 2848. Field Nos. 686, 687 (part) and 689 (part).

Genus **Periophthalmus** Bloch & Schneider, 1801.

Periophthalmus expeditionium, sp. nov.

(Figure 2.)

D. xii/13; A.12 (13); P. 14; V. i, 5; C. 8 + 9 + 8 = 25. More than 60 transverse and about 24 longitudinal scale-rows on body.

Head (11 mm.) 4.8, depth (9) 6 in total length (53). Head about as broad (7 mm.) as high. Eye (3) 3.7, longest (fourth) dorsal spine (7) 1.5, median dorsal rays (5) 2.2, medium anal rays (3.5) 3.1 in head.

Head scaly except before middle of eye-level, around preoperculum, and on its ventral surfaces. Eyes large, contiguous, with distinct lower lids. Snout bluff, broad, rounded. Anterior nostril in pointed protuberance over mouth; posterior near eye. Upper lip expanded laterally into a fleshy fold below preorbital. A similar, shorter fold below side of lower lip. Mouth extending below posterior half of eye. A single row of spaced conic teeth in each jaw, some slightly enlarged; none on palate. Tongue rounded. Gill-opening small, before pectoral base, separated by a broader isthmus. Gillrakers small.

Body elongate, compressed; myomeres indistinct, covered wtih small cycloid scales. An arched genital papilla.

Dorsal fins separate, the first of twelve spines, rounded, slightly longer than high, not as high as body, unspotted and separate from soft dorsal, commencing over the pectoral rays. The spines increase in length until about the fourth or fifth.

Anal opposite second dorsal but smaller than that fin. Pectorals rounded, barely reaching level of vent. Ventrals before pectorals, completely united by median membrane and by anterior frenum to form a sucking disc. Caudal rounded with small, slender, upper reduced rays and thick, finger-like lower rays increasing in length posteriorly.

General colour in alcohol, brown with about eight indistinct crossbars on body. A dusky oblique stripe from upper corner of operculum to bases of pectoral rays. Belly with blue tinge. Apparently no white or silver spots anywhere. First dorsal dark brownish with a light yellow margin. Second dorsal white or yellowish with two broad bands of brown mostly restricted to the membranes. Anal yellowish. Pectorals plain with brownish membranes. Ventrals brown above with light yellow or white margin and pale yellow below. Caudal mostly yellowish but with pairs of brownish spots along the membranes adjacent to the principal rays. Teeth yellowish.

Differs from its congeners in fin and scale-counts, combined with having united ventral fins, and round, unspotted spinous dorsal fin.

Described and figured from the holotype, probably a male, about 2 in. or 53 mm. long from Karumba, Gulf of Carpentaria, Queensland; collected by Charles Hedley about fifty years ago. Austr. Mus. Regd. No. I. 6195. A paratype (I.6196) is very similar but has A.10 (11) and C.23.

The Australian Museum Expedition secured two examples, paratypes, only 22 to 27 mm. long (No. IB 2891; Field No. 214) from the Forrest River Mission, Western Australia; 24 May 1952. The smaller one has a minute spinous dorsal fin. Their colours are various tones of bluish-grey, almost black on soft dorsal membranes.

Range.—Gulf of Carpentaria, Queensland, and north-western Australia.

Genus **Boleophthalmus** Cuv. & Val., 1837.

Boleophthalmus caeruleomaculatus McCulloch & Waite.

Boleophthalmus caeruleomaculatus McCulloch and Waite, Rec. S.Aust. Mus., i, 1918, 79, Pl. viii, fig. 1. Adelaide River, Northern Territory.

This species, hitherto known only from the types in the museums of Adelaide and Sydney, is represented by eight specimens, 1.8 to 5.5 inches overall, from Port Keats and the Forrest River Mission and may now be recorded from Western Australia for the first time.

Austr.Mus. Regd. No.	Field No.	Length in inches overall.	Locality.	
IB. 2836	375	5·5	Forrest River Mission, 29 May, 1952	New record for W.A.
2839	451	5·25	" " " 2 June, 1952	
2840	452	5·5	" " " "	
2844	627	1·85	Port Keats Mission, Northern Territory, 21–6–52	
2847a	688	2·2	" " " " "	26–6–52
2847b	688	2·1	" " " " "	"
2849	687(part)	2·35	" " " " "	"
2850	6~9(part)	1·8	" " " " "	"

This seems an opportune place to describe and figure another new tropical Australian goby from North Queensland, as follows:

Family Gobiidae.

Genus **Cryptocentroides** Popta, 1922.

Cryptocentroides Popta, Zool. Meded. Leiden, vii, 1922, 32. Haplotype. *C. dentatus* Popta from Raha, Indonesia. This species and *Gobius* (*Cryptocentrus*) *stigmatophorus* Beaufort (Zool. Anzeiger, xxxix, 1912, 136 from Waigiou, New Guinea) are nowadays regarded as synonyms of *Amblygobius insignis Seale* (Philip. Journ. Sci., v, 2, 191c, 116, Pl. ii, fig. 1, from the Philippines) and known as *Cryptocentroides insignis* (*see* Koumans, Zool. Meded. Leiden, xviii, 1935, 144).

Cryptocentroides bulbiceps, sp. nov.
(Figure 3.)

D. vi/i, 10; A.i, 9; P. 18. C.14. Sc. 71 to hyp. Tr. 29.

Head (29 mm.) 3.1, depth (19) 4.8, breadth of body (12) 7.6 in standard length (92). Eye (5 mm.) less than snout (6). Interorbital almost overlapped by the fatty orbital tissue (2 mm.).

No ocular tentacle. Tongue convexly rounded. Maxilla reaching below eye. Teeth in villiform bands on jaws and palate. A few front teeth in upper jaw very slightly enlarged. Nostrils small, posterior round, near eye; anterior valved, nearer upper lip.

Head-pores inconspicuous. No occipital crest. No barbels. No fleshy flaps on shoulder-girdle. Head naked except on nape. Cheeks and chin bulging. A few vertical rows of minute papillae arising above upper operculum, one row crossing nape to join its opposite fellow. Other rows in fold each side of chin. A transverse v-shaped fossa across nape behind eyes. Scales small, cycloid. About 20 myomeres between pectoral base and caudal.

Third and fourth dorsal spines elongate. The sixth bifid, perhaps deformed, with about six hair-like rays arising from right side of back nearby. Ventrals united as usual in gobies, nearly reaching vent. Tenth pectoral ray longest. No free pectoral rays. Caudal rounded, nearly as long as head, with fourteen branched rays, the lowermost short.

General colour pale olive, with six dark brown cross-bands, the first on head, second on nape, third divided on base of spinous dorsal to enclose a small patch of pale olive, becoming single on sides and fading out on belly beneath ventrals, the fourth and fifth below soft dorsal and a smoky sixth on caudal root. Head olive-yellow, with elongate bright blue spots, forming oblique dotted lines; pectorals olive, with numerous small round blue spots at its base and on the basal half of the fin; dorsals pale olive, with slightly darker markings on the proximal membranes of the soft dorsal; ventrals dark olive, covered with round bright blue spots; anal fin olive-brown, with about five longitudinal blue lines; caudal hyaline-olive becoming ochre-yellow above and bright bluish on the membranes. Pupil of eye black, with bright green reflections, surrounded by orange-yellow iris. The blue spots at pectoral base have faded away since preservation in formalin.

Described and figured from the holotype, a specimen 92 mm. in standard length or 4¾ in. overall, in the Dept. Harbours and Marine collection, Brisbane, No. 1782.

Locality.—Palm Islands, North Queensland. Coll. T. C. Marshall.

Differs from *C. insignis* (Seale) the only other species in Popta's genus, in coloration and proportions, as described above, in not having very enlarged outer teeth, and in having fewer dorsal and anal rays.

Family Blenniidae.

Genus **Istiblennius** Whitley, 1943.

Istiblennius spaldingi (Macleay).

Salarias spaldingi Macleay, Proc. Linn. Soc. New South Wales, ii, 1878, 358, Pl. ix, fig. 4. Port Darwin, Northern Territory; McCulloch and McNeill, Rec. Austr. Mus., xii, 1918, 12, Pl. iii, fig. 1; Whitley, Austr. Zool., xi, 1945, 42 and W. A. Fisher. Bull., ii, 1948, 27.

D. xii, 19; A. i, 20, P. left 13 right 13. V. i, 2. C. 10 et lat. brev. L. lat. about 11 tubes, ceasing below spinous dorsal.

Head (17 mm.) 4.1, depth (20) 3.5 in standard length (70).

Gill-membranes free from and united across isthmus. More than 100 slender, movable teeth in a single row across each jaw, independently movable, set loosely in gums. Lips entire. Posterior canine each side of dentary. No teeth on vomer. A median, longer than high, occipital crest. A simple nasal, supraorbital and nuchal tentacle on each side, the latter leaf-shaped.

Dorsals not notched. Last ray joined to half uppermost free caudal ray by membrane, last anal ray united to caudal peduncle by a low membrane. Anal spine without dendrites, first three rays elongate and pinnate. Median 6 caudal rays branched.

Colour in alcohol mainly yellowish-brown above and pale yellowish below. About ten very indistinct lateral cross-bars. Pectorals orange-tan, other fins yellowish-grey. No dark blotch on dorsal. No spots on head or body.

One specimen, 70 mm. in standard length or 3.3 inches overall (No. IB.2843, Field No. 600, part) from West Headland, Port Keats, 23rd June, 1952.

Family Lagocephalidae.

Genus **Takifugu** Abe, 1949.

Takifugu Abe, Bull. Biogeogr. Soc. Japan, xiv, 1949, 90.

Haplotype, *Tetrodon oblongus* Bloch.

Abe treated *Takifugu* as a subgenus of *Sphoeroides* as a matter of convenience, but the form of the nostrils and presence of a lower lateral line separate this from *Sphoeroides Anon,* 1798 *sensu stricto,* and Fraser-Brunner (Ann. Mag. Nat. Hist., (11) x, 1943, 9) shows skeletal differences between the two, so that Abe's name evidently deserves generic status.

Takifugu oblongus (Bloch).

(Figure 4.)

Tetrodon oblongus Bloch, Nat. ausl. Fische, ii, 1786, 6, Pl. 146, fig. 1. Surate, Indonesia; Bleeker, Atlas Ichth., v, 1865, 62. Pl. 208, fig. 4. (q.v. for synonymy).

Torquigener oblongus Fraser-Brunner, Ann. Mag. Nat. Hist., (11), x, 1943, 11; J. L. B. Smith, Sea Fish. S. Afr., ed. 2, 1950, 418, no. 1197, Pl. 93.

Sphoeroides oblongus Abe, Bull. Biogeogr. Soc. Japan, xiv, 1949, 94 (and tabulated in his other papers on variation in puffer-fishes).

D. 3, 8; A. 3, 8; P. left 19, right 21. C. 7 or 8 branched rays.

Interorbital greater than snout. Eyes adnate to head (or with small free margin above in smaller specimen). Chin not prominent. Dorsal spines begin on interorbital near nostrils and extend back on head, back, sides and belly to cease abruptly in anterior half of fish. Chin and front of cheeks naked, also area around gill-opening and pectoral fin, and whole of posterior half of fish.

L. lat. inconspicuous in large specimen. In small example, the upper encircles eye, sends a branch around nostril anteriorly, another down cheek, a third over nape; the lower l. lat. runs along posterior part of side to join the upper on caudal peduncle. A short l. lat. below head.

Very slight fold of skin below body posteriorly. Facies as figured. Dorsal margin concave in large, convex in small specimen.

Left pectoral rays, 1 rudimentary + 1 simple + 16 branched + 1 simple = 19.

Right pectoral rays, 1 rudimentary + 1 simple + 18 branched + 1 simple = 21.

Caudal peduncle deeper than thick. Caudal excavate, large.

The Australian Museum expedition obtained three specimens of this widely-distributed species of toadfish, up to 6¾ in. long, at the Forrest River Mission, Western Australia, on 24 May and 2 June, 1952.

Registered No.	Field No.	Total length in inches.	Standard length in mm.	Interorbital in mm.
IB. 2835	211	6·75	144	30
2837	449	4·3	88	20·5
2838	450	4·9	99	21

None of them was banded as in typical *oblongus*, but the smallest was light-spotted. In IB. 2835, the general colour in spirits is greyish-brown above, silvery below; eyes, nostrils, and fins yellow; pectoral base smoky. The others are greyish-brown or muddy coloured, with a slight greenish tinge; snout dusky; a smoky bluish-grey blotch at pectoral axil; a few irregular light areas; fins like body in colour.

Explanation of Figures on Page 125.

1. Chanda Perch, *Blandowskiella dalyensis* (Rendahl). Specimen from Wilson River, Western Australia.
2. Mud-Skipper, *Penophthalmus expeditionium* Whitley Holotype from Karumba, Queensland.
3. Goby, *Cryptocentroides bulbiceps* Whitley. Holotype from Palm Islands, Queensland.
4. Toado, *Takifugu oblongus* (Bloch). Specimen from Forrest River Mission, Western Australia.

The line in each case (except figure 1) represents one inch in the same scale.

STUDIES IN ICHTHYOLOGY

No. 16 *

By Gilbert P. Whitley, F.R.Z.S.
Curator of Fishes, The Australian Museum, Sydney.

(Figures 1-4.)

Family Clupeidae.

Genus **Macrura** van Hasselt, 1823.

Macrura blackburni Whitley.

(Figure 1.)

Macrura blackburni Whitley, Austr. Zool., xi, 1948, 266. Port Hedland, Western Australia.

Here figured for the first time from the holotype (No. IB. 2010) in the Australian Museum.

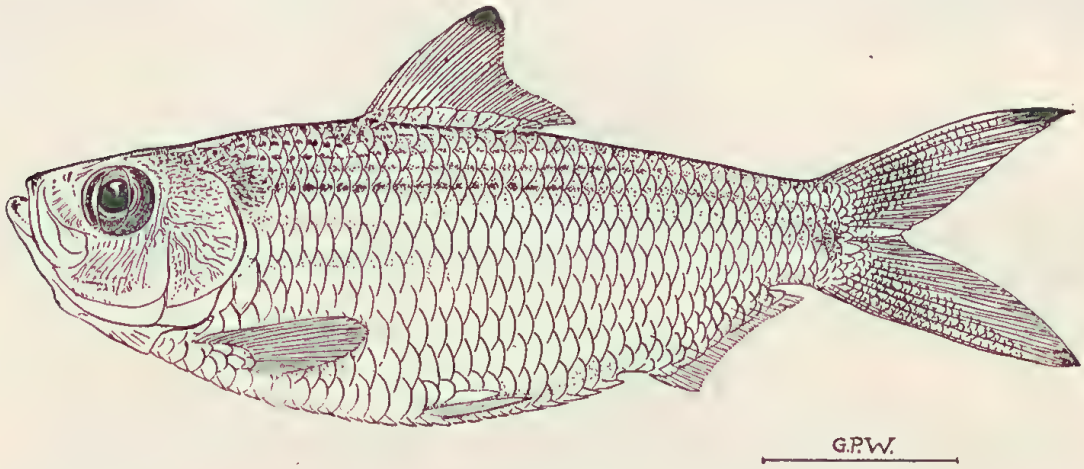


Figure 1.
Herring, *Macrura blackburni* Whitley. Holotype from Western Australia. G.P.W. del. Block by courtesy of the Royal Zoological Society of New South Wales.

Family Cyprinidae.

Bertinichthys, gen. nov.

Orthotype, *Barbus lorteti* Sauvage = *Bertinichthys lorteti.*

New generic name for *Bertinius* Fang (Bull. Mus. Hist. nat. Paris, (2), xv, 1943, 400) preoccupied by *Bertinia* Jousseaume, Bull. Soc. zool. France, viii, 1883, 194, a genus of Mollusca.

Estevea, gen. nov.

Orthotype, *Barbus* (*Hemigrammocapoeta*) *mirei* Esteve = *Estevea mirei.*

New name for *Hemigrammocapoeta* Esteve (Bull. Mus. Hist. nat. Paris, (2), xxiv, 1952, 177, preocc. by *Hemigrammocapoeta* Pellegrin, Bull. Soc. zool. Paris, lii, 1927, 34, another genus of fishes in the same family (type, *H. culiciphaga* Pellegrin).

* For No. 15, see Records of the Australian Museum, vol. xxii, No. 4, August, 1951, p. 389.

Family Anostomidae.

Bondichthys, gen. nov.

Orthotype, *Curimatus mivartii* Steindachner = *Bondichthys mivarti.*

New name for *Bondia* Fernandez-Yepez, Bol. Taxon. Lab. Pesc, i, 1948, 66, preocc. by *Bondia* Newman, Trans. Ent. Soc. London, (2), iii, 1856, 289, a genus of Lepidoptera.

Camposichthys, gen. nov.

Orthotype, *Curimatus simulatus* Eigenmann & Eigenmann = *Camposichthys simulatus.*

New name for *Camposella* Fernandez-Yepez, Bol. Taxon. Lab. Pesc., i, 1948, 60, preocc. by *Camposella* Cole, Ent. News, xxx, 1919, 271, a genus of Diptera.

Family Coronodontidae.

Tiarodontus, gen. nov.

Orthotype, *Diademodus hydei* Harris = *Tiarodontus hydei.*

New name for *Diademodus* J. E. Harris, Proc. Zool. Soc. London, cxx, 1951, 683, preoccupied by *Diademodon* Seeley, Philos. Trans. (B), clxxxv, 1895, 1029, a genus of Reptilia.

Family Ptychodontidae.

Alloptychodus, gen. nov.

Orthotype, *Paraptychodus reimanni* Carter = *Alloptychodus reimanni.*

New name for *Paraptychodus* Carter, Bull. Buffalo Soc. Nat. Hist., xvii, 3, 1942, 11, preocc. by *Paraptychodes* Warren, Novit. Zool., i, 1894, 379, a genus of Lepidoptera.

Family Perleididae.

Mendocinichthys, gen. nov.

Orthotype, *Mendocinia brevis* Bordas = *Mendocinichthys brevis.*

New name for *Mendocinia* Bordas, Physis, xix, 1944, 568, preocc. by *Mendocinia* Jensen-Haurup, Ent. Medd., xiii, 1920, 211, in Hemiptera.

Family Bothidae.

Genus **Mancopsetta** Gill, 1881.

The original introduction of the generic name *Mancopsetta* by Gill in his "Account of Recent Progress in Zoology" (Smithsonian Report, 1880 (1881), 42) seems to have been overlooked by ichthyologists, the genus being credited to "(Gill) Jordan, 1920" in Norman's Monograph of Flatfishes, 1934, p. 247, and in standard Nomenclators.

Family Myctophidae.

Genus **Scopelus** Cuvier, 1816.

Scopelus hookeri, sp. nov.

Myctophum humboldti Waite, Rec. Canterb. Mus., i, 3, 1911, 166, Pl. xxvii, fig. 3. New Zealand. Not *Serpe humboldti* Risso, Ichth. Nice, 1810, 358, from the Mediterranean.

D. 12; A. 21. Lateral line scales slightly enlarged. AO 7 to 9, PA 4 to 9, the first 3 or 4 PA over anal base. One to three small luminous scales above or below caudal peduncle.

Blackish-brown, the lateral scales burnished silvery, photophores mirror-like, eyes bluish, fins whitish. Length, 4½ inches.

This is the Tasman Sea lantern fish regarded by Taning (Vidensk. Medd. Dansk. Foren., xciv, 1932, 129) as *Myctophum humboldti boops*. Richardson (Zool. Erebus & Terror, Fish., 1845, 39, Pl. xxvii, figs. 6-12) described *Myctophum boops* from a specimen sketched by Dr. Joseph Dalton Hooker "captured on the 19th. of January" from "the sea between Australia and New Zealand" and he mentioned some other examples supposed to have been collected "in the China seas" by Sir Edward Belcher. Possibly more than one species was included in his description. In any case, it is evident from Dr. Hooker's own summary of the voyage that he was not in Australasian seas on any 19th of January between 1839 and 1843 in the "Erebus" or "Terror". Thus *Myctophum boops* was evidently not Australian in origin, which would explain why no Australasian specimens so-called agree with Richardson's figures. The subspecific name *Myctophum humboldti barnardi* Taning 1932 is equally unacceptable, applying to a South African form, perhaps even to topotypical *boops*. So I rename the Australasian species *Scopelus hookeri* after Dr. J. D. Hooker, whose exquisite drawings of fishes, made on the "Erebus" and "Terror" voyages, I studied and admired at the British Museum some years ago. The holotype is registered No. IA.1406 in The Australian Museum and the species is found from New South Wales to New Zealand and Lord Howe Island.

Elampadena, gen. nov.

Orthotype, *Scopelus subasper* Gunther = *Elampadena subaspera*.

New name for *Elampa* Fraser-Brunner, Proc. Zool. Soc. London, cxviii, 1949, 1048, preocc. by *Elampus* Spinola, Ins. Liguriae, i, 1806, 10, a genus of Hymenoptera.

Family Syngnathidae.

Nigracus, gen. nov.

Orthotype, *Stigmatopora nigra* Kaup = *Nigracus nigra*.

New name for *Pipettella* Whitley, Proc. Roy. Zool. Soc. New South Wales, 1949-50 (1951), 62, preocc. by *Pipettella* Haeckel, Rept. Voy. Challenger, Zool. xviii, 1, 1887, 304, a genus of Radiolaria.

Family Sparidae.

Taenarichthys, gen. nov.

Orthotype, *Lobodus pedemontanus* Costa = *Taenarichthys pedemontanus*.

New name for *Taenarus* Whitley, Proc. Roy. Zool. Soc. New South Wales, 1949-50 (1951), 67, preocc. by *Taenaris* Huebner, Index exot. Lepidopt., 1821, 4, a genus of Lepidoptera.

Family Scorpaenidae.

Genus **Neocentropogon** Matsubara, 1943.

Having the same genotype, *Paracentropogon aeglefinus* Weber, it is evident that *Gadapistus* Beaufort (Copeia 1949, p. 68) is a synonym of *Neocentropogon* Matsubara (Trans. Sigenkagaku Kenkyusyo ii, 1943, p. 430).

Subfamily Pteroinae.

Genus **Parapterois** Bleeker, 1876.

Parapterois Bleeker (Versl. Meded. Akad. Wet. Amst. (2) ix, 1876, p. 296) has as type *Pterois heterurus* Bleeker, so *Parabrachirus* Matsubara (Trans. Sigenkagaku Kenkyusyo ii, 1943, p. 346), with the same genotype, becomes a synonym.

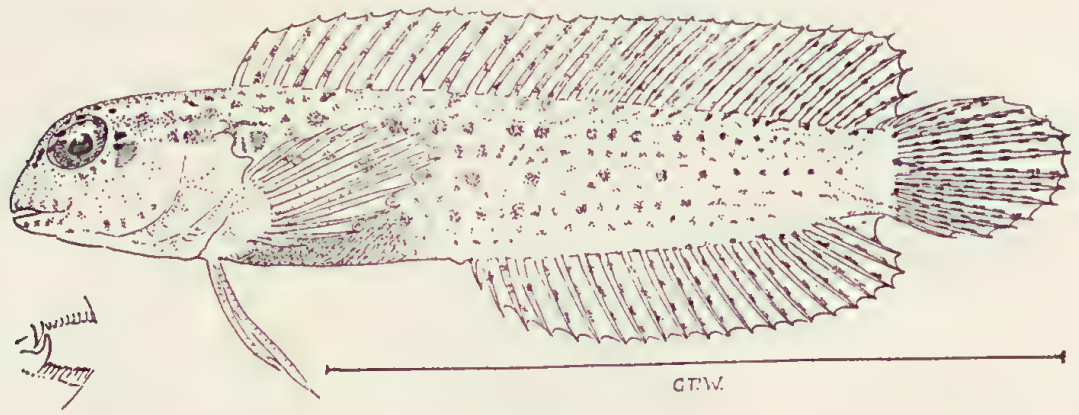


Figure 2.

Blenny, *Graviceps punctatus hyena* Whitley. Holotype of subspecies from Queensland. Inset: teeth from right side. G.P.W. del.

Family Salariidae.

Genus **Graviceps** Fowler, 1903.

Graviceps punctatus hyena, subsp. nov.

(Figure 2.)

Blennechis punctatus Cuvier & Valenciennes, Hist. Nat. Poiss., xi, July 1836, 286. Bombay.

Omobranchus punctatus Swainson, Nat. Hist. Fish. Amphib. Rept., ii, 1839, 274; Norman, Ann. Mag. Nat. Hist., (11), x, 1943, 804.

Petroscirtes punctatus Gunther, Cat. Fish. Brit. Mus., iii, 1861, 231 ("Coast of Australia"), and of Australian lists; Day, Fish. India, i, 1876, 326; Schmeltz, Cat. Mus. Godeff., vii, 1879, 48 (Bowen, Q.); Weber, Siboga Exped., Fische, 1913, 541; Whitley, Rec. Austr. Mus., xvi, 1927, 30 (Q. locs.); Eggert, Zeit. Wiss. Zool., cxxxix, 1931, 448, figs. 70-72 (reproductive organs); Hora & Mukerji, Rec. Ind. Mus., xxxviii, 1936, 35 (Burma) .

D. 31; A. 22; P. 14; V. i, 2: C. 13. Head (8.5 mm.) 3.6, depth (6) 5.1 in standard length (31). Eye (2.1) equals snout, 4 in head. Depth of caudal peduncle, 3.5; snout to anus, 15; predorsal length, 7.5; ventral origin to anal origin, 9; longest pectoral ray, 7; interorbital less than 1 mm.

Head rounded, with blunt, convex profile, without tentacles or barbels. Pores around eye and preoperculum and behind interorbital. Nostril near eye. Mouth curved, overhung by snout, reaching below eye. About ten to twelve teeth each side of each jaw, with posterior canine; that of lower jaw less than pupil. Gill-membranes united across isthmus. Gill-opening before upper pectoral rays.

Body compressed, tapering from above pectoral origin to caudal base. Lateral line reduced to one or two tubes on each side anteriorly. About 27 myomeres from end of pectoral to hypural joint.

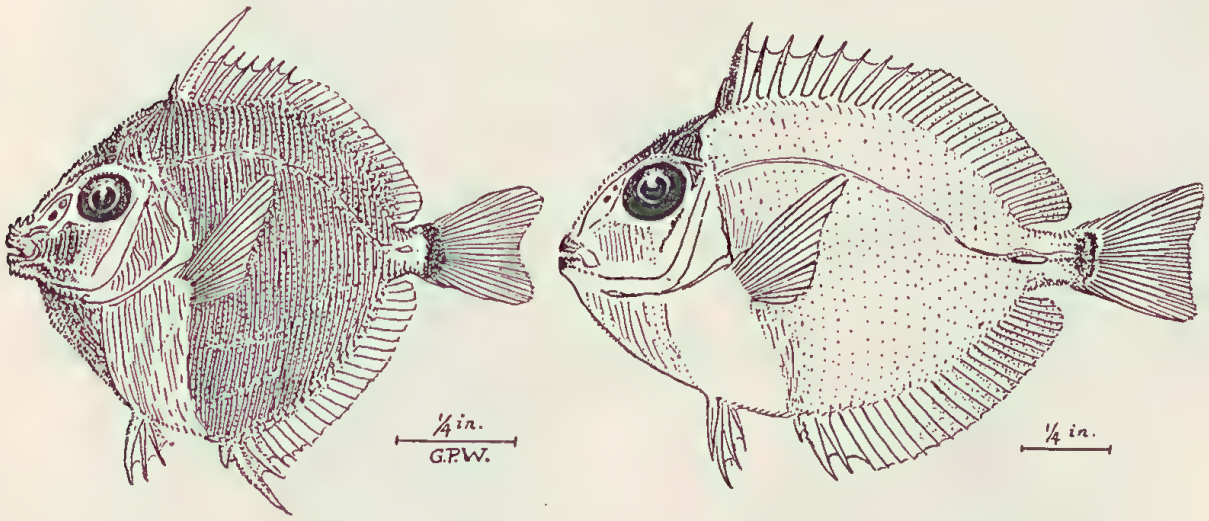
Dorsal fin originating over opercles, increasing in height to about the fourth ray from the last and ending in union with the procurrent caudal rays. Anal slightly lower than dorsal, its last membrane barely free of caudal root. Pectoral bluntly rounded, about as long as ventral. Caudal rounded. All fin-rays simple.

Colour in formalin, yellow with rows of various-sized round, dark brown spots on head, body, and unpaired fins, each spot comprised of a cluster of dot-like chromatophores; some dark blotches are subdermal. On the head the spots tend to break up and form a few indistinct oblique marks below. Along the body they run in about six subhorizontal rows, three of which have larger spots than the others; no horizontal dark lines. A blue spot, subequal to pupil, on head behind eye. A blue tinge on a similar scapular spot. Some of the dark body-spots show a bluish tinge in some lights. Dark brown spots extend along the rays, or adjacent to them, on all the unpaired fins; pectorals and ventrals plain whitish. Eyes, interorbital and viscera blue.

Described and figured from the holotype of the subspecies, a specimen 36 mm. or about 1.4 inches in total length. Austr. Mus. Regd. No. IB. 2889.

Locality.—Palm Islands, Queensland (Dept. of Harbours & Marine, Brisbane, no. 1957).

This is the species which has been recorded from Queensland by authors as *Petroscirtes punctatus* C. & V., but it differs from the typical Indian species in proportions and in lacking any black bars or margins on dorsal and anal fins. It is distinguished from its congeners by its spotted coloration, fin-formulae, situation of dorsal fin, lack of tentacles, and narrow interorbital.



Surgeon Fish, *Teuthis spinifrons* Whitley. Holotype from Maroubra and paratype from Byron Bay, New South Wales. G.P.W. del.

Family Teuthidae.

Genus **Teuthis** Linnaeus, 1766.

Teuthis spinifrons, sp. nov.

(Figures 3 and 4.)

Teuthis sp. Whitley, Austr. Mus. Mag., x, 12. 1952, 403, figs.

D. viii, 21; A. iii, 21; P. 14; V. i, 3? and C. 16.

Facies as figured. Snout and profile spiny. Body unusually deep, scales subvertical, striate. Dorsal fin preceded by a procumbent spine. Spine on caudal peduncle little developed.

Colour brown. Interorbital, front part of soft dorsal fin and posterior part of caudal peduncle blackish. Sides of head and thorax silvery. Eye blue.

Described and figured from the holotype of the species, 22 mm. in standard length or about 26 mm. or 1.1 inches overall. Austr. Mus. Regd. No. 1A. 6419.

Locality.—Washed up on Maroubra Beach, near Sydney in March 1935 and collected by G. P. Whitley.

Other specimens are in the Australian Museum from Caloundra, south Queensland, and Tuggerah, Freshwater, and Queenscliff beaches in New South Wales. The largest paratype is No. IB. 2519 from Byron Bay, New South Wales (fig. 4), 45 mm. or 1.8 inches in total, or nearly 37 mm. in standard length. This has more fin-rays, as if they were split off from the dorsal, anal, and ventral spines: D. ix, 24; A. iii, 24; P. 14; V. i, 4; C. 15. The spines on the head are reduced, the form is more oval, the second dorsal and anal spines are comparatively less elongate and the caudal spine is developed.

General colour pale yellowish. The interorbital black bar extends to over front half of second dorsal spine, with some black on following spines. The ends of the lips are blackish and the dark patch before the root of the tail is more diffuse than in the holotype. Soft dorsal and anal fins infuscated. The flanks are silver and the eyes bluish.

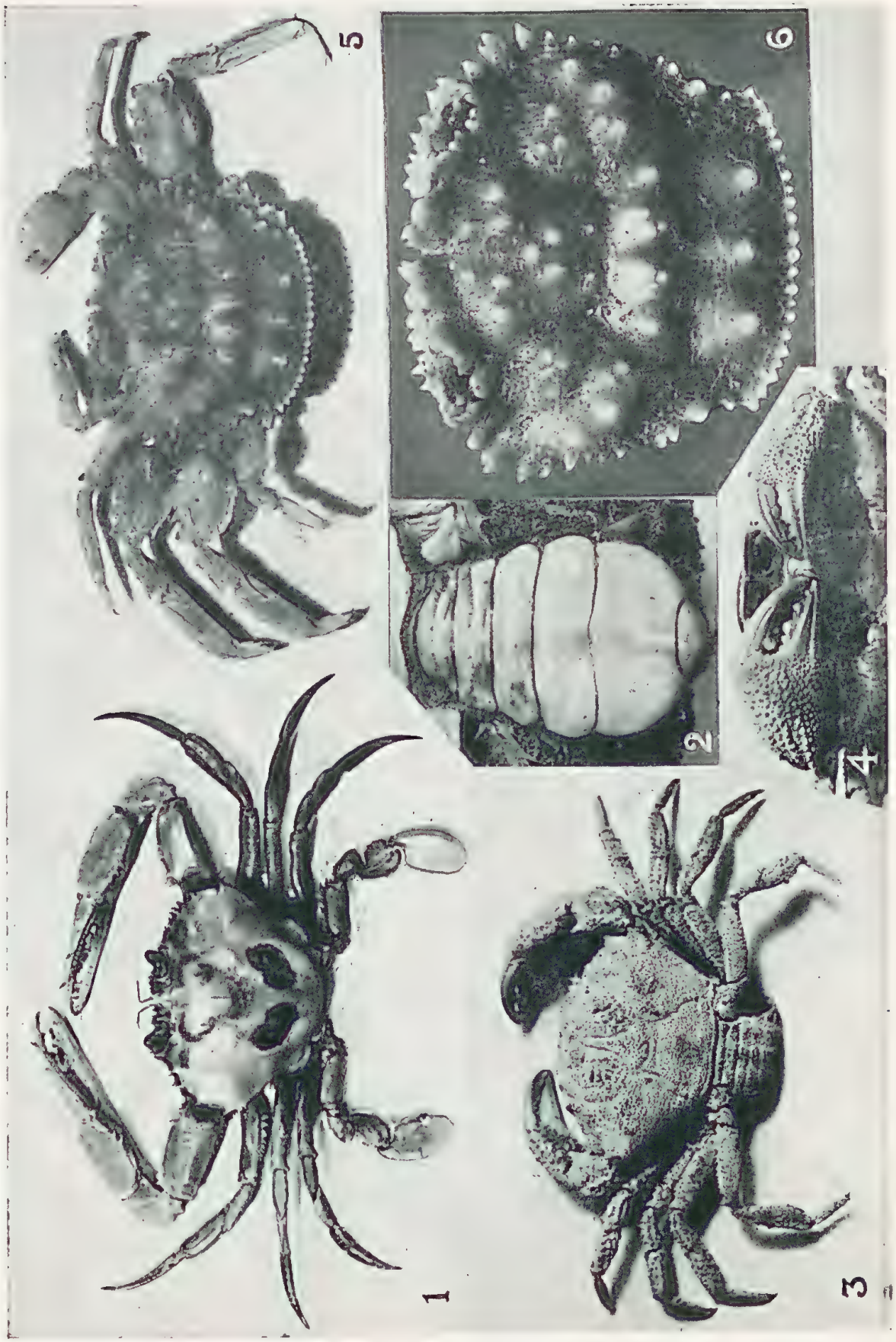
The accompanying figures show the holotype twice natural size and the largest paratype 1½ times natural size.

Since the above was written, the Australian Museum has received specimens of this new species from—

(1) The screens at Bunnerong Powerhouse, Botany Bay, New South Wales; January, 1953 (Mr. W. Courtney).

(2) Hellhole Beach, National Park, New South Wales; February, 1953 (Mr. W. G. Collins).

(3) Budgeevoi Beach, 13 miles north of Wyong, New South Wales; 12 April, 1953 (Mr. John Hutton). Length 41 mm. Body transparent except for a dusky subvertical bar between soft dorsal and anal fins and several grey spots on other parts of the body.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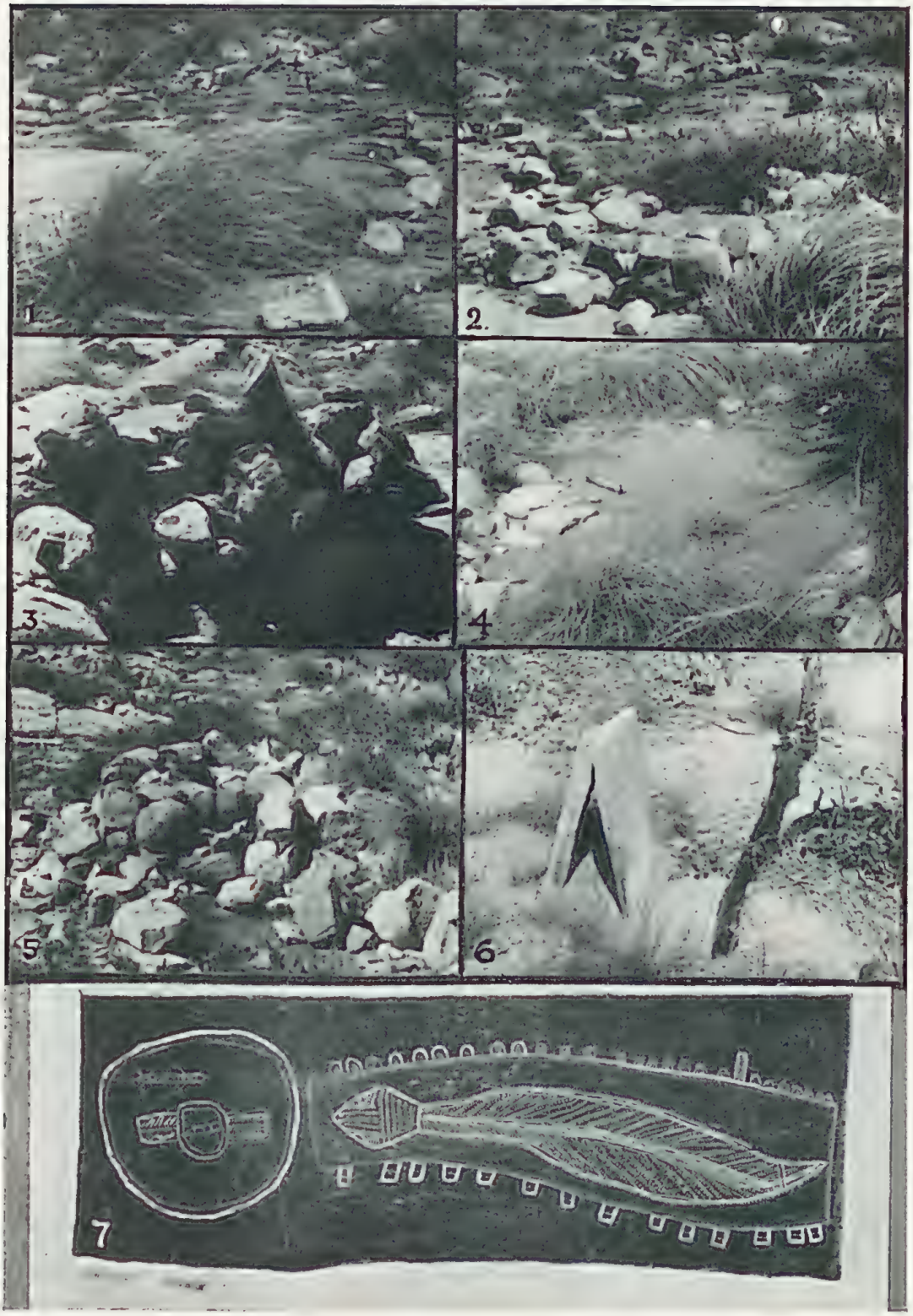
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REVISION OF THE NEW SOUTH WALES TRIPHORIDAE

BY CHARLES F. LASERON, F.R.Z.S.

Honorary Correspondent, Australian Museum.

(Figures 1—30)

INTRODUCTION.

Few groups of mollusca have presented more difficulties to local conchologists than the Triphoridae. Their small size, close resemblance to each other, and the difficulty of obtaining good and adequate material have led largely to their neglect. Yet few groups are more fascinating and worthy of a close examination. Fortunately the late Charles Hedley (1902) revised the local species, and laid a solid foundation on which future workers could build. In his excellent paper not the least service he rendered was to collate and clear up anomalies in the earlier literature, and to illustrate and expand the inadequate descriptions of previously named species. He described several new species, and in all listed fifteen species from the coast of New South Wales.

Since Hedley's paper no further work has been published in New South Wales, though Hedley himself described and reviewed some Queensland and Pacific Island species. May added to the Tasmanian list and Verco did work in South Australia, while B. C. Cotton and F. K. Godfrey proposed a comprehensive classification for the southern Australian species. In New Zealand Sutor, Finlay and Powell also did work on the Neozelandic forms.

The present paper is based mainly on the collections made by my son John and myself during the last twenty years. During that time we have endeavoured to build up series of the different species, to find out the limits of their variability and something of their habitats and distribution. It is rather surprising the number of hitherto undescribed species that have thus come to light. It is to be regretted that the rather rare opportunities were not taken to note something of the animals themselves, for the structure of the operculum, the radula, and the detailed anatomy must be the keys that will ultimately unlock the problems of their phylogenetic relationship.

In addition to our own collection I am indebted to members of the Marine Section of the Royal Zoological Society of New South Wales who have passed material on to me for study, particularly to Miss E. Duff and Mrs. L. H. Woolacott, to Messrs. E. F. Holland, T. A. Garrard and David McAlpine, and also to Mr. Tom Iredale who sorted out a number of white specimens from Manly Ocean Beach. An examination of the material in the Australian Museum was rather disappointing, as most of the specimens have deteriorated through sweating in the glass tubes. It was only possible to check here and there on Hedley's work. This is regrettable, because with two of his species Hedley made an extraordinary and unusual mistake by drawing as type one species and describing another. The confusion thus created will, I think, be straightened out when discussing the two species in question, *cinerea* and *nocturna*. Curiously enough the material in the Museum collected earlier by the late John Brazier is in much better condition. One specimen, selected as type of a new species, was collected in 1878. Brazier's specimens were all neatly mounted on cards and annotated in his own writing.

All types and also all specimens illustrated in this paper have been presented to the Australian Museum, where they will be kept intact as a type collection for future reference.

Family Triphoridae.

The main characteristic of the Triphoridae from shell features alone is the sinistral coiling, accompanied by an elongate, many-whorled shell. They are operculate; the operculum is thin, round, pauci- to multi-spiral with a central nucleus. The aperture varies considerably and may be very complex. The columella consists of a broad pillar, and may be straight, bent or twisted. An anterior canal is always present, while the posterior canal may vary from an elongated tube to a shallow subsutural notch or sinus.

In some tropical forms the aperture develops in an extraordinary manner. The outer margin is expanded both anteriorly and posteriorly into tubular processes, and the anterior canal is greatly extended; even the aperture itself may be elongated and tubular, so that the shell has the appearance of having three mouths. This type has so far not been recorded from New South Wales waters. All the local species yet examined have rather similar and comparatively simple apertures.

In its simplest form, as in *Notosinister granifera*, the aperture is rounded or subquadrangular with a thin outer lip, a shallow subsutural posterior sinus, and another shallow sinus adjacent to the anterior canal. The canal itself is short and may be recurved backwards. In many species the anterior sinus continues to expand after maturity, and grows upwards into an acute fold which extends across the canal and partially across the pillar of the columella. The presence or absence of this spur has distinct specific value, but in some species its growth is evidently slow after maturity and its absence in specimens cannot be taken as conclusive. It is also easily broken, and the break, particularly in the smaller species, is not easy to detect.

The protoconch is of great importance for at least specific determination and, as in other families, any difference may be taken as indicating specific difference. Just how far the protoconch has genetic value is still undecided. Finlay (1928) based his genus *Notosinister* on a multi-whorled sculptured protoconch, but while his genus may be admitted on other grounds, the protoconch alone is here rather unsatisfactory. If *Notosinister* is accepted on general grounds, the Neozelandic genotype has its Australian paratype in *N. granifera*, and with this quite a number of other species can be satisfactorily grouped. Other species, such as *labiata*, *maculosa* and others, have thick and at times tumid protoconchs, and at first it was thought that these could be better considered under another generic name. The difference here would seem, however, to be more of size than of essential character, and moreover there are many intermediate species which preclude a hard and fast division.

In a very valuable paper in 1931, Cotton and Godfrey reviewed the South Australian species and, following Finlay, adopted a classification based entirely on the protoconch. They divided the group into six genera, *Notosinister*, *Cautor* and *Teretriphora* all of Finlay, with three, *Eutriphora*, *Isotriphora* and *Hypotriphora*, proposed as new. Of these, *Isotriphora* seems a natural group including several closely related species, and *Hypotriphora* from shell characters alone is so distinctive that it deserves generic rank. The status of *Eutriphora* is uncertain as it contains incongruous elements. If adopted it would include the New South Wales species *nocturna*, which by other characters is far nearer to such species as *regina*, *fasciata* and *innotabilis*, included by these authors in other genera. *Teretriphora* of Finlay is a good genus, but its application to many Australian species is, I think, quite unnatural, particularly such species as *angasi*, which has quite a different shell. Only one local species, *kestevenі*, a very distinctive shell, has sufficient resemblance to the New Zealand genotype to be included with it. The application of *Cautor* to Australian shells has proved quite unsatisfactory, as quite incongruous and unrelated species are grouped together. The same may be said of *Notosinister* but, if this be used in a wide sense, it can be divided into fairly natural groups, and a key devised for the recognition

of the local species. The genetic status of these groups is left in abeyance. Much depends on the future study of a great number of undescribed species living on the Queensland coast. Many of these can be linked with species on the New South Wales coast, but others have quite different characters and have no close relationship. No classification of the Australian Triphoras can be satisfactory until all these are included.

The protoconch of all the local species seems to begin with a smooth dome-shaped whorl in which, under strong magnification, a minute nucleus can sometimes be seen enfolded. On the second or third whorl a spiral keel develops, on either side of which are minute transverse threads. The latter are not always apparent, as the slightest wear removes them. Adult sculpture appears quite suddenly at anything from the third to the sixth whorl, and in one species, *N. regina,* a distinct varix was noticed. In one group only, of which *tasmanica* is an example, the apex is of quite a different type and suggests an entirely different life history. For this group Cotton and Godfrey have proposed the genus *Isotriphora*. In *Isotriphora* the apex is rounded and covered with tubercles which, on close examination, are seen to be the mature sculpture on two or three rapidly expanding whorls. The true protoconch is invisible, unless a minute, smooth dome, only visible under strong magnification, shows where it is deeply immersed in the summit (see Fig. 23*a*).

The sculpture is very important in specific determination, and is nearly constant in the different species. It is both spiral and transverse, the former producing prominent keels which are broken into rows of more or less rounded gemmules by the latter. In *Notosinister* and *Austrosinister* there are typically three rows of gemmules, with a fourth on the body-whorl, which is overlapped and may appear as a sutural thread on the earlier whorls. The three rows of gemmules are generally equal, but in one group of species, of which *N. fasciata* is typical, the centre row on the body-whorl is much smaller than the other two; on the penultimate whorl it is little more than a thread, and higher up the spire it disappears altogether. The gemmules may be larger or smaller, may be rounded, and may be quite separate or fused together. In *N. cinerea* they rise as protuberances above well defined linear keels. The transverse sculpture consists of costae, which may be well defined, as in *N. cinerea,* or they may be quite obsolete in the grooves between the gemmule rows, their presence indicated only by the gemmules themselves, which are opposite to each other and are arranged in lines obliquely ascending the spire. The gemmules are not always rounded, but may be irregular and more or less angular, and their summits are sometimes flat and faceted. Other smaller details of the sculpture will be dealt with when describing the various species, but unfortunately my limitations as a draughtsman have prevented it being more than indicated on the figures. The number of gemmules on the whorls is very constant, and has been determined by counting the number visible on the front of the body-whorl and multiplying by two. This is accurate within one or two. The difference in appearance of say 14, 17, 20 or 23 gemmules to the whorl is very marked, and can be taken as a constant specific character.

Rows of gemmules are characteristic of most of the family, but there are certain odd species which differ radically, and may indeed, apart from their sinistral coiling, have little relationship to the main group. Of these the shell named by Hedley *Triphora kesteveni* is an example. In this the gemmules are entirely absent, and the sculpture consists of three equal, broad, flat, spiral keels, serrated at the edges, and separated by deep, narrow channels. Finlay (1926) proposed *Teretriphora* for a rather similar Neozelandic shell, but he based his genus on a 4-whorled smooth protoconch and not on the sculpture. For the time being at least the species *kesteveni* may be placed here. An extraordinary shell from Port Stephens has two smooth, sharp-edged, outstanding keels with a small thread-like keel between them, and for this the new genus *Solosinister* is proposed later in the paper. Still another shell,

exceptionally large for the family, has very distinctive sculpture. In this two keels bearing low gemmules lie at the top and bottom of the whorls, and are so close to similar keels on adjacent whorls that the suture is reduced to a mere thread. Between these keels transverse costae rise in the centre to obscure gemmules to make an indistinct median row. The new name *Magnosinister* is proposed later for this shell.

In each species the number of whorls is nearly constant in the mature shell, though occasionally it may vary by one or at the most by two. Size is the most variable character and adult individuals of the one species may be found one-third or as much as half again as long as others. Relative length and breadth are nearly constant, but in some species individuals are found relatively somewhat broader than others. The straightness or convexity of the spire is also specifically constant, and the tendency of some species to be contracted at the base gives them a distinct facies.

Colour, usually unreliable in most families, in the Triphoridae is remarkably constant, so much so that it is a very useful guide in the recognition of species. In some, such as *Notosinister regina* and *N. tricolor,* it enables even fragments to be recognized.

The habitat of the Triphoridae is mainly on or in the vicinity of rocky reefs, and generally below the limit of low tide. A few species live in crevices or below rocks in pools on the foreshore, and these are the species commonly found washed up on the beach. Most of those seen alive have been in ones or twos, but on one occasion we found a whole colony of *N. labiata* living among *Galiolaria* tubes in North Harbour, Port Jackson, and well above low-tide level. Odd specimens have also been found crawling on seaweed in the pools. Many species apparently live on the reefs in much deeper water, on ground difficult to dredge. Such would be washed up on the shore only occasionally, and this no doubt accounts for the paucity of specimens available. A glimpse of such a fauna was obtained in a fortunate dredging in 14 fathoms on a gravelly patch between reefs about two miles from the shore at Long Reef near Sydney. From here came three of the new species described, as well as worn and broken specimens of others, quite different, but too imperfect to describe. On the trawling grounds of the South Coast, in depths of from 30 to 60 fathoms, Triphoras seem nearly entirely absent. Hedley recorded two specimens of *Isotriphora tasmanica* from the "Thetis" Expedition, and from numerous parcels of sand and mud we ourselves have found only two immature specimens. The absence of reefs well out on the continental shelf probably accounts for their rarity.

The geographical range of most species of *Triphora* seems limited, and the occurrence of the one species in more than one zoogeographical province always needs very careful checking. Several species appear in the Tasmanian list as common to both that State and New South Wales, *cinerea, angasi, fasciata, innotabilis, maculosa* and *tasmanica.* Of these *angasi* will be shown later as erroneously recorded from New South Wales, true *tasmanica* and *fasciata* may occur on the South Coast, and *maculosa* seems definitely common to the two States. On the other hand the occurrence of *cinerea* and *innotabilis* in Tasmania requires further checking. With Victoria and South Australia there is still greater difference, and it is doubtful if there is one species common with New South Wales. Careful comparison side by side under the microscope is the only sure way identity can be established, and general resemblance can be very misleading. Thus the occurrence of the species *ampulla* on the New Zealand list is probably incorrect.

Relationship with the Queensland Triphoras is at present very uncertain. There is in Queensland a great number of species, few of which have been identified, and the majority of which are undescribed. My son John has been recently making

a collection of small shells from Queensland, and has already sorted out more than three times as many species of *Triphora* as have previously been recorded from the area. Of these, numerous species from the coral reefs of the Capricorn Group are quite dissimilar from any in New South Wales. On the other hand those from the mainland at Bowen and Caloundra have much the same facies, and many are found closely related to but distinct from the more southern species. A few species are in common, particularly as there is inevitably some overlap between the two provinces. *Notosinister cinerea* and *Teretriphora kesteveni* have already been recorded from Queensland. *Notosinister maculosa* is in my son's collection from Alexandria Heads, near Caloundra in southern Queensland, and from the same locality is an immature specimen indistinguishable from *N. topazica*. At the same time typical Queensland species may be expected from time to time from the extreme north coast of New South Wales.

Key to the New South Wales Triphoridae

Genus *Notosinister*. Sculpture thre rows of gemmules, protoconch from three to five whorls, bearing keels.
- Group A. Small stout shells, protoconch thick and club shaped.
  1. *N. maculosa*. Protoconch white, mature shell yellowish brown with patches of chocolate.
  2. *N. univitta*. Protoconch white, first mature whorl chocolate, remainder buff, sutures brown.
  3. *N. conferta*. Golden-brown, protoconch and base yellow-brown.
  4. *N. tricolor*. Protoconch yellow-brown, first three mature whorls white, remainder deep red-brown, upper row of gemmules greenish.
  5. *N. sarcira*. White with splashes of orange-brown.
  6. *N. labiata*. Deep red-brown, almost black.
  7. *N. robusta*. Protoconch white, remainder white or pale yellow-brown.
- Group B. Intermediate between Groups A and C. Small stout shells, with protoconchs rather slenderer than A.
  8. *N. pocula*. White with brown base.
  9. *N. ampulla*. Alternate patches of white and brown.
- Group C. Slender multi-whorled protoconchs with keeled whorls. Three equal rows of gemmules.
  10. *N. granifera*. Yellow-brown, upper rows of gemmules lighter.
  11. *N. topazica*. Golden-brown, shell slender.
  12. *N. alborda*. Protoconch and base brown, spire cream.
  13. *N. glaciala*. Pure white.
  14. *N. jacksonensis*. Brown with white gemmules.
  15. *N. albovittata*. Pale yellow, upper row of gemmules white, with narrow line of ochre.
- Group D. Protoconch 4–5 whorls, slender and keeled. Rows of gemmules unequal in size, only two rows on upper part of spire.
  16. *N. innotabilis*. Yellow-buff, shell slender.
  17. *N. regina*. White with orange line on lower row of gemmules.
  18. *N. fasciata*. White, gemmules on lowest row largest.
  19. *N. nocturna*. Shell large and slender, deep brown.
- Group E. Shell stout, protoconch minute.
  20. *N. fulvalinearis*. Gemmules straw-coloured, sutures and base chocolate, furrows brown.
- Group F. Protoconch short, with two keels on whorls. Spiral sculpture strong.
  21. *N. cinerea*. Ashy white gemmules, general tinting ashy.
  22. *N. stramentia*. Shell very slender, pale straw colour.
  23. *N. grandiosa*. Shell very large, deep red-brown, pale gemmules.

Genus *Isotriphora*. Apex rounded and sculptured, protoconch deeply immersed. Sculpture as in *Notosinister*.
  24. *I. echina*. Yellow-buff, 28 gemmules to the whorl.
  25. *I. tasmanica*. Yellow-buff, 20 gemmules to the whorl.

Genus *Teretriphora*. Sculpture three broad, flat, spiral keels.
  26. *T. kesteveni*. Colour cream.

Genus *Solosinister*. Sculpture two prominent sharp keels with smaller keels between.
  27. *S. pagoda*. Pale yellow-buff.

Genus *Magnosinister*. Shell very large, two narrow keels at bottom and top of whorls, with transverse sculpture between.
  28. *M. hedleyi*. Yellowish white, faded.

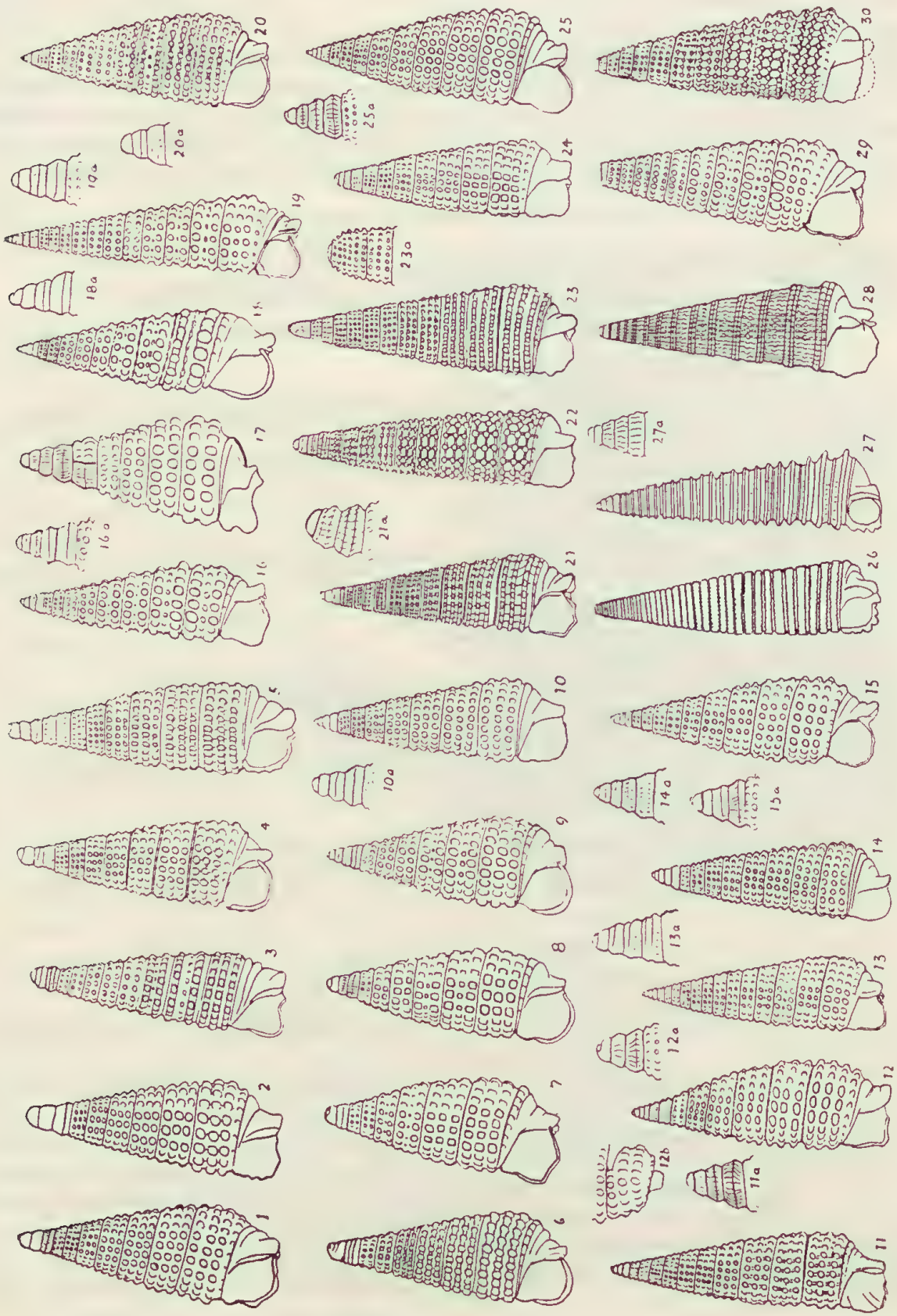
Description of Species.

Genus **Notosinister** Finlay, 1926.

Genotype, *Triphora fascelina* Sutor. Australian paratype, *Triphora granifera* Brazier.

Finlay's genus, founded on the protoconch alone, is here enlarged to take in Triphoras with typical sculpture of three rows of gemmules, simple apertures in which the posterior canal is reduced to a subsutural slit or sinus, the anterior canal is short and open, the columella pillar broad, the anterior margin of the aperture sometimes expanded into a narrow fold or spur which may reach or partially cross the columella. The protoconch begins as a smooth dome, a keel developing on the second or third whorl, while transverse sculpture may appear as minute threads. The whole protoconch may have from two to five whorls, and adult sculpture appears quite abruptly.

Within *Notosinister* as thus defined are several groups of closely related species, linked, however, with intermediate forms, thus precluding further generic separation. B. C. Cotton has already used *Notosinister* for the South Australian species *pfeifferi*, which is one of what might be called the *fasciata* group of species.



Figures 1-30. (For explanation see p. 158.)

Notosinister maculosa Hedley.

(Figure 1.)

Hedley 587.

N. maculosa is the first of seven species, small to medium in size, with thick short protoconchs of from two to three whorls, short, rather stout shells with a tendency to convex or bottle-shaped spires. There are small but constant differences between these species, but the colour pattern as given in the key to species is a ready means for their quick recognition.

N. maculosa is one of the commonest species, and is found on beaches both inside and outside the harbours right along the coast, and ranging also to Tasmania and southern Queensland. It is very constant in size, sculpture, aperture and colouring. The protoconch is white, the remainder of the shell yellowish-brown, variegated with patches of chocolate. The gemmules are large, about twenty to the whorl, and are confluent to form continuous keels. The sutures are wide and deep. A spur on the anterior margin of the aperture reaches the columella. The specimen figured is from Crookhaven Heads and is 6 mm. long by 2.1 mm. wide.

Notosinister univitta, sp. nov.

(Figure 2.)

Shell of small size, protoconch white, first mature whorl yellow-brown, next deep chocolate, remainder pale yellow-buff with white gemmules, base darker, sutures chocolate. Form broadly conical, sides straight. Protoconch of three whorls, stout, the first dome-shaped, the next smooth, a keel appearing on the third. Mature whorls six, increasing regularly, sutures distinct but narrower than in *maculosa*. Sculpture three rows of gemmules, a fourth keel with indistinct gemmules on the body-whorl. The gemmules are large and rounded, about sixteen to the whorl, joined by low bars to form keels, and also by low ridges from row to row. Aperture subquadrate, outer margin thin, indented by the sculpture, a shallow sinus at posterior and anterior ends, no spur developed, but this may be due to insufficient maturity, canal short. Columella pillar very broad and bent back at its extremity, a narrow layer of callus within the aperture. Base flat, with one flattened fold. Length 5.1 mm., width 1.9 mm.

Locality.—14 fathoms off Long Reef (four specimens).

Remarks.—This species is closely related to *N. maculosa* which was found in the same locality, but it can be readily separated by its smaller size and distinctive colouring. It also has three whorls in the protoconch instead of two, the gemmules are larger and fewer, the columella is broader and different in shape, the sutures are narrower, and the gemmules are connected across the sutures.

Notosinister conferta, sp. nov.

(Figure 3.)

Shell small, cylindrical, rather narrow, bright yellow-brown, apex yellow, base red-brown. Protoconch tumid, of three whorls, the first dome-shaped, the second swollen with a faint keel, the third short, faintly keeled with faint cross sculpture. Mature whorls eight, increasing regularly, sutures very narrow and deep. Sculpture three rows of gemmules on the body-whorl, the uppermost the most prominent, the other two equal, the gemmules about twenty to the whorl, prominent but rather irregular in shape, confluent to form definite keels. The furrows between the keels are narrow

and deep. On the penultimate whorl the lower row of gemmules is the most prominent, and the median row is much smaller, becoming reduced to a thread and then disappearing as the spire is ascended. There is a keel without gemmules on the periphery of the body-whorl and another on the base. The aperture is subquadrate, the anal sinus shallow and wide, the anterior spur is not developed, the canal short and open in front, the pillar of the columella broad and rounded anteriorly, slightly bent back, a thick wide layer of callus within the aperture. Length 4.4 mm., width 1.2 mm.

Locality.—Pittwater.

Remarks.—This alone of the group of species with thick protoconchs has the peculiar sculpture associated with *N. fasciata, N. nocturna* and cognate species, the median row of gemmules disappearing as the spire is ascended. It is also narrower than related species, and the shape of the columella is distinctive. Its nearest relative is probably *N. labiata.*

Notosinister tricolor, sp. nov.

(Figure 4.)

Shell of medium size, conical, spire very slightly convex, stout. Colour of protoconch yellow-brown, first three mature whorls white, remainder as a whole almost black, but close examination shows the central row of gemmules to be brown and the upper and lower sage-green; base brown. Protoconch of three whorls, the first small and dome-shaped, the second inflated, the third short with an incipient keel. Mature whorls eight, increasing regularly, nearly flat, sutures shallow with a thread formed by the overlapping of the fourth gemmule row visible on the body-whorl. The sculpture consists of three rows of gemmules, equal in magnitude, about twenty gemmules to the whorl. The gemmules are close together, prominent and confluent to form definite keels, rather irregular in shape and sometimes almost quadrangular. The furrows between the keels are very narrow and are bridged by small, low, barely distinguishable transverse ridges. Base with a prominent extra keel. Aperture rounded, posterior subsutural notch narrow and deep, anterior margin with a prominent spur which partially crosses the columella. Columella pillar rather narrower than others in the group, straight and anteriorly rounded, a thick band of callus within the aperture. Length 7.5 mm., width 2.3 mm.

Locality.—Crookhaven Heads (type); Long Reef; Cronulla.

Remarks.—From all other species with thick protoconchs this differs in proportions, details of the protoconch, aperture and sculpture. Its nearest relative is *N. maculosa* from which it is easily separated by its distinctive colouring, which is such a good recognition point that even fragments may be readily determined.

Notosinister sarcira, sp. nov.

(Figure 5.)

Shell of medium size, bottle-shaped, slender above and swollen below, white with irregular splashes of orange-brown, base yellow. Protoconch of four whorls, the first small and dome-shaped, the next two tumid and smooth, the fourth with a keel. Mature whorls eight, at first increasing rapidly, the last three nearly equal, sutures smooth and indented. Sculpture, three regular, equal spiral keels, rather wider than the furrows, each broken into small, raised, confluent gemmules, rounded and about 24 to the whorl. Base with three extra spiral keels. Aperture subquadrate, outer margin rounded and thick, no anal notch or sinus visible, posterior spur not reaching the columella, canal short and broad, visible from in front, oblique. Columella pillar short, broad and rounded, more than half covered by a thick layer of callus extending well within the aperture. Length 6.8 mm., width 2 mm.

Locality.—14 fathoms off Long Reef (two specimens).

Remarks.—The four-whorled protoconch, the unique bottle-shape, and details of the sculpture and aperture separate this from all other members of this group. The colouring should also prove a ready recognition point. It is apparently an inhabitant of the deeper reefs, and so far has never been seen upon the shore.

Notosinister labiata Adams.

(Figure 6.)

Hedley 586.

This is one of the commonest Sydney species, and though the original description was very brief, the observation "a small, nearly black shell, with the outer lip dirty white or pale fuscous" makes it very easy to recognize. Hedley gave a full description and excellent figures, so its identity is not open to question. Examination of long series, however, shows that, within limits, there is variation in size and proportions. A colony found living in galiolaria tubes in North Harbour was composed of individuals rather smaller than usual, averaging less than 4 mm. The specimen figured is from this locality, and is 3.5 mm. long by 1.2 mm. wide. A series taken from dredgings in 10 fathoms, Doll's Point, George's River, was considerably larger and somewhat slenderer, averaging more than 5 mm. in length, and with from 7 to 9 mature whorls. A feature of the protoconch not shown in Hedley's figure is the slightly tilted and infolded initial whorl. The gemmules are rather irregular in form, sometimes quite rounded, sometimes angular, and they are confluent to form definite keels much wider than the grooves between. The median row becomes smaller as the spire is ascended, but not to so marked a degree as in *N. conferta*. *N. labiata* is also common right along the coast.

Notosinister robusta, sp. nov.

(Figure 7.)

Shell small, broadly conical, with a convex spire and broad blunt apex, protoconch white, remainder white or pale yellow, base yellow. Protoconch tumid, the initial whorl dome-shaped and set obliquely, the second smooth and inflated, the third with a keel. Mature whorls six, short, the body-whorl restricted at the base, sutures distinct, marked by a narrow line, above which is a thread of very small gemmules, caused by the overlapping of the whorls. The sculpture consists of three rows of large gemmules, confluent to form definite keels, and also linked transversely by narrow bars across the very narrow grooves. A fourth row is on the periphery of the body-whorl. The gemmules themselves are large, about 18 to the whorl, close together, and irregular in shape, elevated, but flattened on top. Aperture expanded, angular, outer margin thin, posteriorly recessed into a moderately deep sinus right on the suture, anterior spur prominent and partially crossing the columella, canal short and broad. Base with two prominent keels, columella short, broad, tapering and rounded anteriorly, with a layer of callus within the aperture. Length 4.4 mm., breadth 1.7 mm.

Locality.—Dredged 6-9 fathoms, Sow and Pigs Reef (two specimens).

Remarks.—This species is very close to *N. labiata,* so much so that opinions might differ as to whether subspecific status is all that is justified. But the colour is quite different, it is much broader, the gemmules are much larger, and the aperture is more angular.

Notosinister pocula, sp. nov.

(Figure 8.)

Shell very small, broadly conical, spire convex, acuminate, contracted anteriorly. Colour white, base brown. Protoconch of four whorls, small, initial whorl small, dome-shaped, second whorl smooth, third and fourth keeled and with transverse threads. Mature whorls six, increasing regularly, the spire slightly convex, the body-whorl restricted anteriorly, sutures shallow but defined, marked by a beaded thread. On the body-whorl there are three main rows of gemmules, with a fourth on the periphery; the upper row of gemmules are the largest, those on the two lower rows are somewhat smaller. The gemmules are large, rounded, but rather irregular, separate and not joined from row to row. They number about nineteen to the whorl. On the penultimate whorl the median row of gemmules is much smaller, on the whorl above smaller still, and above this there are only two rows. The aperture is somewhat expanded, the outer margin thin and rounded, and bent back posteriorly to form a notch against the suture. Anteriorly the margin is broadly folded, but there is no spur, and the fold does not extend to the columella. An extra fold appears on the base, and the columella is short, broad and tapering and rounded anteriorly, with a thick layer of callus within the aperture. Length 2.7 mm., breadth .9 mm.

Locality.—Yamba, Clarence River, North Coast.

Remarks.—This is the smallest of the New South Wales species yet seen. It may be grouped with the next species, *N. ampulla,* both shells having the broad, convex contour of the *maculosa-labiata* group, but with finer more acuminate protoconchs, linking them with *granifera* and other species to be discussed later.

Notosinister ampulla Hedley.

(Figure 9.)

Hedley 579.

This is rather a rare shell on the coast, but its colour is so distinctive that it can be readily recognized, as each whorl is chequered with alternate white and brown patches, and the contour is bottle-shaped, the apex acuminate, and the base slightly restricted. We have found it in shell sand at Cronulla, but the figure is taken from a specimen in the Australian Museum collected by J. Brazier alive in a large rock pool at Little Coogee near Sydney in 1895. Brazier's specimens differ slightly from Hedley's description and figure; they are mature but somewhat smaller and broader, and have but six mature whorls instead of nine. A specimen from Cronulla has seven. The spur of the anterior margin of the aperture also partially crosses the columella, whereas Hedley speaks of it as not reaching the columella. The protoconch, sculpture and shape of the columella are, however, the same, and it is evident that the species is rather variable. The dimensions of the specimen figured are: length 3.1 mm., breadth 1.1 mm.

Notosinister granifera Brazier.

(Figures 10, 10*a*.)

Hedley 583.

This is another of the common species, and it is found on beaches all along the New South Wales coast, but is rarely seen alive. The only living specimens we have seen were on seaweed in pools on the foreshore at North Harbour, Port Jackson. These were rather smaller than the average. The specimen illustrated is from shell

sand from Point Halliday on the North Coast, and is 4.7 mm. long and 1.3 mm. broad. This is about the average size, though specimens have been seen well over 5 mm. The colour when alive is yellow-brown, but beach specimens are generally faded and much lighter. A characteristic of the colouring is that the upper row of gemmules is generally much lighter, a feature also found in the allied species *albovittata*. *N. granifera* is the first of a number of species with straight-sided spires in contrast to the convexity of the *labiata* group; they are slenderer also, with acuminate apices. The protoconch is four-whorled, the first smooth and dome-shaped, the next three keeled with fine transverse threads. The sculpture consists of three rows of equal rounded gemmules, closely packed, about twenty-three to the whorl. Hedley says that there is no spur on the anterior margin of the aperture, and in all the specimens we have seen this is so, and the aperture is always simple with a short open canal.

Notosinister topazica, sp. nov.

(Figures 11, 11*a*.)

Shell of medium size, long and slender, acuminate, colour a rich golden-brown, the sutures and, in the upper whorls, the upper row of gemmules deep chocolate, base chocolate. Protoconch acuminate, of four whorls, the first dome-shaped, the next with faint transverse threads, the next two keeled with fine transverse threads. Mature whorls ten, increasing regularly, sutures broad and deep. Sculpture three equal rows of medium-sized, round gemmules, about twenty-two to the whorl, connected by low rounded ridges to form the keels, and also connected by faint ridges transversely from row to row. A fourth keel with indistinct gemmules on the periphery of the body whorl. The three gemmule rows persist almost to the summit of the spire. Aperture subquadrate, outer margin thin, curving back posteriorly, but the anal notch is not deep, anterior margin simple with no spur, canal broad and open. Base with an extra spiral keel, columella pillar rather narrow and bent slightly backwards. Length 6 mm., breadth 1.5 mm.

Locality.—Cronulla (type), collected by Mr. E. F. Holland; on outer beaches, fairly common.

Remarks.—Though fairly common on the outer beaches, good specimens are difficult to obtain and, when worn and the brilliant colour is faded, they are difficult to separate from *N. granifera*, to which they are closely related. They are, however, much longer and slenderer, and differ in details of the aperture and sculpture.

Notosinister alborda, sp. nov.

(Figures 12, 12*a*, 12*b*.)

Shell small, broadly conical, spire convex, restricted at base, protoconch brown, base chocolate, remainder cream with the upper row of gemmules white and underlined by a very thin brown line. Protoconch thin, of four whorls, the first small and infolded, the next with faint transverse threads, the fourth keeled faintly also with transverse threads. Mature whorls eight, the body whorl restricted at the base, sutures narrow and deep. The sculpture consists of three regular, equal rows of gemmules, about twenty to the whorl, two rows only on the first three whorls, and a fourth on the periphery of the body-whorl. The gemmules are moderate in size, rounded and linked together to form definite keels, but are not connected from row to row; they are rather wider than the channels. An extra keel appears on the rather truncate base. Aperture subquadrate, outer margin angular and thin, bent back at the suture to form a deep anal slit, no spur on the anterior margin, canal open, short and broad. The columella is short, broad and rounded anteriorly, slightly recurved backwards and with a vertical furrow. Length 3.6 mm., breadth 1.3 mm.

Locality.—14 fathoms, off Long Reef.

Remarks.—Apart from its broad, convex shape, this is very close to *N. granifera*, of which it was at first thought merely to be a subspecies. Comparison of the two side by side beneath the microscope, however, shows that *N. alborda* has a slenderer protoconch with much less defined keels, the mature sculpture is coarser, the gemmules larger and fewer, the columella is broader, and the anal notch deeper. The colour should again be a ready recognition mark.

Notosinister glaciala, sp. nov.

(Figures 13, 13*a*.)

Shell of medium size, long and slender, acuminate, spire very slightly convex, colour pure white. Protoconch of five whorls, the first dome-shaped, the second smooth, the next three slightly keeled with faint transverse threads. Mature whorls thirteen, short, regular, sutures narrow but defined. The sculpture consists of three rows of gemmules, about twenty to the whorl, an extra row on the body-whorl, the uppermost row the largest, the rows close together. The gemmules are moderately large, closely packed together, irregular in shape, on the body-whorl becoming almost rectangular. On the penultimate whorl the middle row of gemmules is smaller and fades entirely as the spire is ascended. Base smooth and excavate. Aperture subquadrate, outer margin bent back to form a shallow anal notch, anterior margin bent into a spur which just reaches the columella, canal short and twisted backwards. Columella short and broad, rounded anteriorly, a thick layer of callus, almost a plate, within the aperture. Length 6.4 mm., breadth 1.7 mm. (type); another mature specimen slightly less than 5 mm. in length.

Locality.—6-9 fathoms, Sow and Pigs Reef, Port Jackson (type); Pittwater; also outer beaches.

Remarks.—A pure white *Triphora* has long been known to local collectors, but it has been difficult to obtain specimens good enough to describe. It is apparently variable in size, and in a series collected by Mr. Tom Iredale from the Ocean Beach, Manly, the variation amounts to as much as one-third in length, and also slightly in breadth. A single imperfect specimen of a white *Triphora* dredged in Quarantine Bay is still slenderer, and is 9 mm. in length, but this is probably a different and undescribed species. In its relationship *N. glaciala* would seem to be intermediate between the species like *granifera* with three equal rows of gemmules, and others like *innotabilis* and *fasciata* in which the rows are very unequal with only two rows higher up the spire. Its slender form and white colour make it very easy to recognize.

Notosinister jacksonensis, sp. nov.

(Figures 14, 14*a*, 25, 25*a*.)

Hedley 580 (*Triphora angasi* Crosse & Fischer).

Shell of medium size, evenly conical with straight sides, rather slender, colour red-brown, gemmules paler or even white. Protoconch of five whorls, the first dome-shaped, remainder with sharp keels and fine transverse threads. Mature whorls eight, increasing regularly, very slightly rounded, sutures wide and deep. Sculpture three rows of equal gemmules, about twenty-three to the whorl, the three rows persisting up the spire, with a fourth on the periphery of the body-whorl. The gemmules are close together, rather elongated or oval transversely to the keels, with small incipient gemmules in the narrow furrows between the keels. The base has an extra spiral keel and is rather excavate. The outer margin of the aperture is rounded and thin, the anal sinus is broad and shallow, and the anterior margin is folded into a very

small spur which does not cross the canal. The pillar of the columella is rather narrow and bent back slightly. The type may be barely mature. Length 5.5 mm., width, 1.6 mm.

Localities.—Living in kelp roots, North Harbour, Port Jackson (type); also dredged in North Harbour.

Remarks.—This is the shell recorded by Hedley from Port Jackson as *Triphora angasi* Crosse & Fischer. Hedley published a description (without the protoconch), and stated that he identified specimens by comparison with others from the type locality in South Australia, and that, though the Sydney specimens were larger and proportionately broader, he was satisfied that they were the same. The protoconch, however, proves that they are distinct. *Triphora angasi* is stated by Crosse & Fischer (1865) to have "the first three whorls smooth," while the Sydney shell has a five-whorled, sculptured protoconch. A good recognition point for this species is the whiteness of the gemmules against the brown ground. *T. angasi* is now removed from the New South Wales list.

Figure 25 is from a specimen in the Australian Museum collected by J. Brazier from 5 fathoms off Bottle and Glass Rocks in 1879. This is somewhat broader than the type, and is 5.4 mm. long by 1.8 mm. wide. It was drawn as a distinct species, but close comparison shows the essential features to be similar, and it probably represents about the extreme in variation of the species. It is yellowish in colour, but has probably faded in the long time since its collection. It is also more mature than the type and shows the characters of the aperture better.

While discussing this species, the status of *Triphora nigrofusca* A. Adams might again be considered. Tryon included it in his list of rejected species, but Hedley was reluctant to do this and described and figured a shell he thought might be it. From Adams's original inadequate description all there is to go upon is that it was collected at low water under stones in Port Jackson by Mr. Strange, and that it is a black-brown species with three rows of regular, equal-sized granules on each whorl. The type should be in the British Museum, but it was not among those which Hedley examined when in London in 1912, and which he figured in the following years. The few features in Adams's description would fit several Sydney shells, *N. jacksonensis* among them, and it is doubtful if what is the true *nigrofusca* will ever be known. Curiously enough the shell selected by Hedley definitely does not fit the meagre data and, following Tryon's example, it will greatly clarify matters if *nigrofusca* be finally rejected from literature.

Notosinister albovittata Hedley.

(Figures 15, 15*a*.)

Hedley 578.

When Hedley described *albovittata* his type had an imperfect aperture, and he stated that it might prove to be a variety of *N. granifera*. He gave as the characteristic colouring of *albovittata* "pale yellow; upper row of gemmules on each whorl white, beneath them a narrow line of ochre, base and protoconch ochreous." *N. granifera* also has the upper row of gemmules lighter in colour, but specimens we have collected show that Hedley's *albovittata* is quite valid and distinct. The main difference is in the aperture, for in *albovittata* the columella pillar is broader and bent slightly backwards, and the anterior margin of the aperture is bent into a very sharp and long spur which reaches well up and partially across the columella. The outer margin is also recessed sharply backwards posteriorly to form a fairly deep notch against the suture. This is not a very common species, and may inhabit fairly deep water. The specimen illustrated is from 8 fathoms, Doll's Point, George's River, its length 4.1 mm., and breadth 1 mm.

Notosinister innotabilis Hedley.

(Figures 16, 16*a*.)

Hedley 584.

This is the first of several species in which the gemmules are few, large and rounded, and in which the size of the rows is very unequal, giving a very definite facies to the group. In some of the *granifera* type of species, the median row fades in the earlier whorls, and in *glaciala* we had an intermediate stage, but now the inequality is very marked, and one row of gemmules predominates over the others. *N. innotabilis* is rather rare, but is a well-defined species, small and slender, yellow-buff in colour, with a five-whorled protoconch, and a spur crossing the columella. On the body-whorl the lower row of gemmules is the largest, the median row is very small and soon disappears as the spire is ascended. The specimen figured is from eight fathoms, Doll's Point, George's River, and is 3.7 mm. long by 0.9 mm. wide.

Notosinister regina Hedley.

(Figures 17, 29.)

This species does not appear on Hedley's Check List, and it was evidently accidentally omitted. It was described from one specimen with no protoconch and a broken aperture but, as Hedley remarked, the white shell with a narrow orange line along the lowest gemmule row, and the orange tip to the canal should render possible the recognition of any fragment. Occasional specimens we have collected have been likewise imperfect, but an immature specimen from kelp roots in 30-35 fathoms off Crookhaven has a perfect protoconch, which allows some addition to the original description. The specimen is only 2 mm. long, and has four narrow adult whorls, each bearing two rows of large, rounded gemmules, about eighteen to the whorl, the lower with the characteristic orange band. The protoconch has five whorls, the first dome-shaped, the others keeled, with transverse threads, and separated from the adult sculpture by a distinct varix. It is apparently closely related to *N. innotabilis* and other members of the same group. Still another specimen collected by Mrs. Woolacott from Cronulla, though without the apex, has a perfect aperture (Fig. 29). This is subquadrangular with a distinct anal notch, and the spur is pronounced and partially crosses the columella. The columella is rounded, bent backwards, and there are three prominent rounded keels on the base.

Notosinister fasciata Ten.-Woods.

(Figures 18, 18*a*.)

Hedley 582.

It is very doubtful if the specimen here figured is the true *fasciata,* and quite probably it needs a new specific name. Hedley figured and described a shell from Port Jackson which he identified as *Triphora fasciata,* but to date we have found nothing which exactly fits with this, though the specimen figured is very close. Hedley's specimen is described as small, narrow, white, the base and supersutural thread orange-brown, the protoconch of five and a half whorls. The dimensions given are length 5.5 mm., breadth 1.5 mm. Figure 18 is of a shell dredged in 6 to 9 fathoms Sow and Pigs Reef, and relatively broader, its length 4.7 mm., its breadth 1.5 mm. Its colour is white only, the protoconch, which is rather worn, has apparently only four and a half whorls, and there is a prominent spur on the anterior margin of the aperture reaching partly across the columella. The sculpture is identical, the lowest row of gemmules on the body-whorl much the larger, the gemmules themselves large rounded bosses, the median row very small and reduced to a thread on the penultimate whorl.

A single white shell from Cronulla Beach is somewhat nearer Hedley's figure. It lacks the protoconch, but the aperture is complete, showing the anterior margin with a small fold, not a spur, which does not reach the columella. It is quite possible that this character only develops slowly after maturity and cannot always be relied on for specific identification.

A much larger shell with a five-whorled protoconch occurs in dredgings off Lakes Entrance in Victoria, but this seems closer to *N. pfeifferi,* the South Australian species, which also belongs to the same group. Broken specimens resembling this have been seen from the extreme south coast of New South Wales, and it is possible that this species overlaps into the Peronian Province. More and better material is needed before this question can be satisfactorily settled.

Notosinister nocturna Hedley.

(Figures 19, 19*a*.)

Hedley 589.

Hedley's description is very full and clear, but unfortunately he made the extraordinary mistake of figuring quite a different species, probably *N. cinerea,* and this has led to much confusion. In preference to a specimen from our own collection I am therefore figuring one in the Australian Museum, No. C.13158, from Pearl Bay, Port Jackson, labelled *Triphora nocturna* by Hedley himself, and exactly fitting the description. This is a large shell, 10 mm. long and 3 mm. broad, deep brown in colour, with the sculpture typical of the group, two rows of large, boss-like gemmules on the body-whorl, with a row of smaller gemmules between, the median row greatly reduced on the penultimate whorl, and rapidly disappearing as the spire is ascended. It is not a common species, but we have it in dredgings from North Harbour, and it is very easily recognized by its size, colour and sculpture.

Notosinister fulvalinearis, sp. nov.

(Figures 20, 20*a*.)

A medium to large shell, conical, broad, acuminate, spire convex. Colour very distinctive, the gemmules straw-coloured, the sutures and base chocolate, the furrows between the keels yellow-brown. Protoconch very small and acuminate, of three whorls, the first smooth and dome-shaped, the second with one and the third with two faint keels, between which are faint transverse threads. Mature whorls ten, short, sutures wide and deep, marked with a nodular thread. The sculpture on the body-whorl consists of three distinct keels, above which rise rather elongated rounded gemmules, small and about twenty-four to the whorl. The gemmules are linked from row to row, but this character is apt to be overlooked in the deep colour of the channels. On the whorl above the penultimate the median row of gemmules is very small; above this it rapidly disappears and the upper part of the spire has only two rows. A fourth row is on the periphery of the body-whorl. Aperture with outer margin rounded, a deep narrow, anal notch, and a sharp anterior spur reaching the columella, and covering the canal. Base with two extra, wide, rounded spiral keels, the columella short, a flat plate of brown callus within the aperture. Length 5 mm., breadth 1.7 mm. (type); another specimen 7 mm. long.

Localities.—Little Coogee (type), specimen in Australian Museum, collected by John Brazier in 1896; Cronulla Beach (Mr. E. F. Holland); Port Stephens (self); Woolgoolga (Mrs. Woolacott).

Remarks.—This is a very distinctive species not closely related to any other species on the coast. Its broad form and distinctive colouring make it very easy to recognize, even though in size it is rather variable.

Notosinister cinerea Hedley.

(Figures 21, 21*a*.)

Hedley 581.

The main difficulty in identifying this species is that it is probably the most variable of all those from New South Wales, and also that Hedley again made the extraordinary mistake of describing one species and figuring another. Fortunately his description is full and informative and there can be no doubt of the species he had in mind. The colour in fresh specimens is brownish with a white protoconch, marbled with ashy-white, or with the gemmules ashy-white, the base yellow-brown. Beach specimens are generally faded to a uniform ashy tint, as are dead specimens dredged from deeper water. The protoconch is distinctive, short, of three whorls, the first smooth and tilted, the others with two keels, and transverse, fairly coarse threads or bars. The size is variable, as is the sculpture in detail, though it follows one general pattern. Three prominent keels are always present, a fourth on the body-whorl, which is overlapped in the earlier whorls and appears as a nodular thread in the sutures. The keels are crossed by distinct transverse costae, about 20 on the body-whorl dividing the channels into pits, the costae where they cross the keels rising into gemmules, which may be comparatively large, quite small or even virtually obsolete. The spur on the anterior margin is sharp and prominent, reaching partially across the columella and turning upwards into the aperture. The variation in size of the gemmules produces a different appearance in many specimens, as does the variation in size and the number of whorls. Most of the beach specimens have 10 or 11 whorls, and range in size from 7 to 8 mm. long. That figured was taken alive under rocks at Long Reef by David MacAlpine, and is 7.6 mm. long and 2 mm. wide. Apparently mature specimens have been seen with only 8 whorls and less than 6 mm. in length. On the other hand single specimens taken rather rarely in the deeper water of Port Jackson are much larger. One from 5 fathoms in Quarantine Bay has 13 whorls and is 10.5 mm. long. In these solitary large specimens there is much variation in the size of the gemmules, so much so that it would seem at first sight that two or three species are represented. Indeed no two specimens are exactly alike. The two figures which Hedley wrongly applied to his own descriptions of *nocturna* and *nigrofusca* are probably both rather extreme examples of *cinerea* in which the gemmules are nearly obsolete.

In its distribution *cinerea* is exceedingly common on beaches, both inside and outside the harbours, both north and south of Sydney, as far at least as Port Stephens in the north and Jervis Bay in the south.

Notosinister stramentia, sp. nov.

(Figure 22.)

Shell small, slender, cylindrical with very little taper and a blunt apex. Colour uniformly pale-straw. Protoconch comparatively large, blunt, of four whorls, the first dome-shaped and smooth, two keels developing on the third and fourth whorls, with faint transverse threads. Mature whorls eight, short, flat, sutures narrow but deep. Sculpture three equal rows of gemmules, moderately large, about 15 to the whorl, spaced and connected by bars to form definite keels. They are also linked from row to row by rounded transverse costae, leaving in the grooves deep, nearly circular pits, rather smaller than shown in the figure. A fourth keel with smaller gemmules is on the periphery of the body-whorl. Base in the type plain and excavate, but this may not be quite mature. Aperture subquadrate, again perhaps not quite mature, outer lip thin, indented by the sculpture, with neither anal notch nor anterior spur apparent, columella rather narrow, rounded anteriorly. Length 4.1 mm., breadth 0.9 mm.

Locality.—Hawkes Bay, Port Stephens, in shell sand.

Remarks.—The type is probably not quite mature, and the characters of the aperture may not be fully developed, but the slender and cylindrical shell, the large blunt protoconch and the sculpture should make its future recognition easy. Of the local species it is closely linked with *cinerea* by the development of a second keel on the protoconch, and the strong transverse sculpture producing deep pits between the keels. Some undescribed Queensland species have a rather similar facies.

Notosinister grandiosa, sp. nov.

(Figure 30.)

Shell exceptionally large, conical, almost cylindrical in the later whorls, tapering more rapidly towards the apex, colour deep red-brown with lighter gemmules. Protoconch unknown. The type has ten whorls, short, slightly convex, the sutures wide and deep and marked by a nodulose thread. The sculpture consists of three rows of small rounded gemmules, about 24 to the whorl, connected to each other by short bars to form the keels, and transversely from row to row by similar low bars, persistent right to the sutures. A fourth keel with incipient gemmules on the body-whorl, and a faint smooth keel on the rather excavate base. Aperture imperfect, but the columella with a thick vertical plate inside the aperture. Length 12.5 mm., probably 14 mm. in the perfect shell, breadth 3.8 mm.

Locality.—Woolgoolga (one specimen).

Remarks.—I have ventured to name this species from a single imperfect specimen, because its huge size separates it from all other members of the genus; moreover, its sculpture, general form and colouring are distinctive, and should make it easily recognizable in the future. By its distinct transverse sculpture it comes within the small *cinerea* group, but the gemmules are well rounded and distinct, and the connecting bars are low and at first sight not so apparent.

Genus **Isotriphora** Cotton and Godfrey, 1931.

Genotype, *Isotriphora tasmanica* (Ten.-Woods).

Shell characters as in *Notosinister*, but protoconch not visible, appearing merely as a minute dome completely immersed in the rounded blunt apex. Mature sculpture appears at once, the apex being covered with gemmules, the first one or two whorls being nearly involute.

Genera based solely on the protoconch are apt to be unsatisfactory, but this apex is so singular and easily recognized in the small group of southern Australian species which possess it, that giving it generic rank should avoid rather than create confusion. Moreover, it suggests some distinctive change in the early life history of the animal itself.

Isotriphora echina, sp. nov.

(Figures 23, 23*a*.)

Shell rather above the average size for the family, elongate, regularly conical, colour uniformly yellow-buff. Apex with a small flat dome-shaped nucleus, prominent gemmules then appearing similar to that on the main spire, probably belonging to two or three whorls before the sutures are distinguishable. Additional whorls 14, increasing regularly, short, flat, sutures narrow and moderately deep, distinct. The sculpture consists of three subequal keels, separated by narrow channels, a fourth on the body-whorl, the keels broken into rather irregular gemmules, small and packed closely together, about 28 to the whorl. Base flat with one extra flat spiral keel. Aperture rounded, the outer margin thin, straight when laterally viewed, and nearly

entirely enclosing a deep, rounded anal notch, like the base of an incipient tube, anterior margin bent into a sharp spur which reaches the columella, to which it is apparently attached, thus enclosing the anterior canal. Columella tapering, rounded anteriorly. Length 7 mm., width 2 mm.

Locality.—14 fathoms, off Long Reef, a number of specimens.

Remarks.—Hedley identified *Triphora tasmanica* from a single, immature specimen, dredged in 100 fathoms, east of Wollongong. This may possibly be *I. echina,* but cannot be accurately determined. *I. echina* differs from the Tasmanian *tasmanica,* which has the same remarkable apex and is congeneric, by its much finer sculpture, the gemmules being smaller and much more numerous. There is another shell from Lakes Entrance, Victoria, with a similar apex, coarser sculpture and lilac in colour, which is probably still another species of *Isotriphora.* This I believe is undescribed and needs a new specific name.

Isotriphora tasmanica (Ten.-Woods).

(Figure 24.)

Hedley 590.

I am indebted to Mr. T. A. Garrard for a specimen of what may be the true *tasmanica* collected at Twofold Bay, and which is here figured. It is 5.9 mm. long and 1.9 mm. broad. It is similar in many ways to *I. echina* but the gemmules are much larger and more regular, with a tendency to be rectangular, and are only about 19 to the whorl. The outer margin of the aperture is slightly broken, but there is still a rounded subsutural depression which may be the remains of a similar deep anal notch. The spur on the anterior margin is present, but does not reach the columella, leaving the front of the canal quite open. There are also only nine mature whorls instead of 14. Subject to confirmation of the identity of this shell with the Tasmanian species, *I. tasmanica* may therefore remain on the New South Wales list.

Genus **Teretriphora** Finlay, 1926.

Genotype, *Teretriphora huttoni* Sutor. Australian paratype, *Triphora kesteveni* Hedley.

Finlay based his genus on a 4-whorled smooth protoconch, not a very satisfactory character under the circumstances, inasmuch as on this alone he considered the South Australian *Triphora angasi* as congeneric, whereas on other shell characters *T. angasi* is a typical *Notosinister* akin to *N. granifera* and other species on the Australian coast. The sculpture of Finlay's genotype is, however, distinctive, consisting of three broad, smooth, spiral keels, entirely without gemmules, not unlike a *Seila* in reverse. If these characters be taken as a basis, at least one New South Wales species and possibly others from Queensland will come within *Teretriphora.*

Teretriphora kesteveni Hedley.

(Figure 26.)

Hedley 585.

Hedley described this species from a single worn specimen without protoconch or a complete aperture, remarking that it differed nevertheless greatly from all other species known from this coast. A better specimen from Port Stephens enables some particulars to be added to the original description. This shows the broad flat keels to be not quite smooth, but under the microscope to be transversely striated and so

divided into closely-packed flat plates. The keels are separated by deep narrow channels, and the edges are corrugated, probably the incipient production of gemmules. The aperture is quadrate, the outer margin thick, its outside indented by the sculpture, the anal notch is not apparent, there is no anterior spur, and the canal is short and open from in front. The base has two extra spiral keels, the columella is short and tapering, and recurved backwards, and bears within the aperture a separate thick flat plate. The colour of the whole shell is cream. The specimen figured is 10 mm. long by 2.1 mm. broad. The protoconch is still unknown.

A fragment of a shell found in 14 fathoms off Long Reef may be another species of *Teretriphora* as it has the same type of sculpture. This must have been an extremely attenuated shell as in seven whorls 7 mm. in length, the taper is only from 1.7 mm. to 1.5 mm.

Genus **Solosinister,** gen. nov.

Genotype, *Solosinister pagoda* Laseron.

A sinistral shell of very distinct sculpture, each whorl bearing two very prominent, spiral keels, tapering to a narrow flat edge, with a third thread-like keel between them. Transverse sculpture confined to minute threads between the keels. Protoconch many-whorled, short and tapering, with faint keels and transverse threads. Aperture not perfect in the genotype, but apparently simple as in *Notosinister.*

Solosinister pagoda, sp. nov.

(Figures 27, 27*a*.)

Shell of medium size, elongate, cylindrical, spire even, colour uniformly pale yellow-buff. Protoconch tapering rapidly, of five short whorls, the first smooth and dome-shaped, incipient sculpture on the second, the remainder with traces of a keel and transverse threads. Mature whorls 12, even, restricted at the sutures. Sculpture very distinctive, on each whorl two prominent, sharp, spiral keels, tapering to a narrow flat summit, smooth, with a third narrow, small keel between them, a fourth narrow keel on the periphery of the body-whorl. Transverse sculpture confined to minute threads between the keels. Base smooth and excavate. Aperture small, nearly circular, outside margin thick, smooth internally, externally showing the keels, anal notch not visible, canal small and within the columella, pillar of columella straight, internally covered with a narrow plate. Length 6 mm., breadth 1.5 mm.

Locality.—Shell sand, Port Stephens.

Remarks.—The distinctive sculpture, utterly unlike any *Triphora* from the southern Australian coasts, at once distinguishes this species. Fragments of a very similar shell have been seen from Caloundra, Queensland, with the transverse threads between the keels more defined. When drawing the type the protoconch became detached, but has been kept with the mature shell in the same container.

Genus **Magnosinister,** gen. nov.

Genotype, *Magnosinister hedleyi* Laseron.

This genus is proposed for very large species of the Triphoridae with the sculpture consisting of two narrow keels bearing low gemmules at the top and bottom of the whorls, in such close juxtaposition to those on the adjoining whorls that the sutures are reduced to a mere line. Between the keels are numerous low transverse costae rising slightly in the centre to form a median row of small gemmules. Aperture simple as in *Notosinister,* no anal notch apparent. Protoconch unknown.

Macrosinister hedleyi, sp. nov.

(Figure 28.)

Shell exceptionally large for the family, regularly conical, colour pale-straw to white, but may be bleached. Protoconch so far unknown. Whorls 13, short, flat-sided, sides of spire straight, sutures very narrow between keels on adjacent whorls. The sculpture is in low relief but distinctive. It consists of two narrow, prominent keels at the top and bottom of each whorl, in such close juxtaposition to those on the adjoining whorls that the suture is reduced to a very shallow groove between them. These keels are broken into low swellings, hardly gemmules, about 28 to the whorl, and are connected transversely by the same number of low rounded costae which rise slightly in the centre to form a median row of imperfect small gemmules. An extra keel on the periphery of the body-whorl stops short of the margin of the aperture, leaving a small anal recess. Aperture subquadrangular, outer margin thin and indented by the sculpture, anterior margin folded into a sharp spur which partially crosses the columella, completely enclosing the short canal. Columella tapering and rounded, bearing a large vertical plate within the aperture. Length 17 mm., breadth 4.4 mm.

Localities.—Type collected by C. Hedley, Little Coogee, No. C.31448, Australian Museum; 14 fathoms, off Long Reef; Point Halliday; and beaches on North Coast.

Remarks.—The exceptional size and distinctive sculpture make this outstanding among local species, and there should be no difficulty in its recognition. It is not common on the shore, being apparently an inhabitant of the deeper reefs, and the occasional specimens found on the beach are generally so rubbed that they appear nearly smooth. A specimen from Point Halliday had been chosen as type, when the one figured was found in the Museum collection labelled by Hedley *Triphora* n. sp. As he obviously intended to describe it, it is fitting that it should be named after this great conchologist and former friend.

Figures 1–30.

1. *Notosinister maculosa* Hedley; 2. *N. univitta* Laseron; 3. *N. conferta* Laseron; 4. *N. tricolor* Laseron; 5. *N. sarcira* Laseron; 6. *N. labiata* A. Adams; 7. *N. robusta* Laseron; 8. *N. pocula* Laseron; 9. *N. ampulla* Hedley; 10, 10*a*. *N. granifera* Brazier; 11, 11*a*. *N. topazica* Laseron; 12, 12*a*, 12*b*. *N. alborda* Laseron; 13, 13*a*. *N. glaciala* Laseron; 14, 14*a*. *N. jacksonensis* Laseron; 15, 15*a*. *N. albovittata* Hedley; 16, 16*a*. *N. innotabilis* Hedley; 17. *N. regina* Hedley; 18, 18*a*. *N. fasciata* Ten.-Woods; 19, 19*a*. *N. nocturna* Hedley; 20, 20*a*. *N. fulvalinearis* Laseron; 21, 21*a*. *N. cinerea* Hedley; 22. *N. stramentia* Laseron; 23, 23*a*. *Isotriphora echina* Laseron; 24. *I. tasmanica* Ten.-Woods; 25, 25*a*. *Notosinister jacksonensis* Laseron; 26. *Teretriphora kesteveni* Hedley; 27, 27*a*. *Solosinister pagoda* Laseron; 28. *Magnosinister hedleyi* Laseron; 29. *Notosinister regina* Hedley; 30. *N. grandiosa* Laseron.

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A RE-EXAMINATION OF THE UPPER TERTIARY MAYFLIES DESCRIBED BY ETHERIDGE AND OLLIFF FROM THE VEGETABLE CREEK TIN-FIELD

By E. F. Riek.

Commonwealth Scientific and Industrial Research Organization—Division of Entomology, Canberra, A.C.T.

(Plate x.)

Etheridge fil. and Olliff described under the name *Ephemera culleni* a series of fossil mayfly nymphs from the youngest Tertiary stanniferous lead of the Vegetable Creek Tin-field near Emmaville, New England District of New South Wales. The beds are generally considered to be of Pliocene age. There was no designated holotype and they figured nine specimens in their plate. The specimen considered as an adult with a partly preserved wing and described first in the description of the species is best considered as the holotype of *culleni*. This specimen, Figure 5 of the plate, bearing the numbers D112 and F1323, is not an adult but only a nymph. Lying close to it is fragmentary plant tissue showing cellular structure which was considered as the wing of the specimen. Figure 9 of the plate shows a quite different type of nymph of which there are further unfigured specimens.

The two species present in the material are very different, even to the extent of being placed in different families, the Leptophlebiidae and the Baetidae.

From the very good state of preservation, with the nymphs mainly lying flat and undistorted, it would seem that they were living on the mud in which they are now preserved. This would indicate very slow flowing water or more probably standing water. If the water was only of a semi-permanent nature the nymphs would die as the mud dried up, the Leptophlebiidae crawling around and dying outstretched, the Baetidae, with their shrimp-like springing, tending to be slightly curved and lying on the side in some cases.

Family Leptophlebiidae.

Genus **Atalophlebia** Eaton, 1881.

Genotype, *Ephemera australis* Walker, 1853.

This is one of the common Australian genera of the family. The nymphs can be found in fast-flowing streams or sluggish to even standing waters. There are only one or two species which can survive in water which stops flowing for some part of the year. Amongst these is *A. costalis* Burmeister, a species very common along the east coast.

The nymphs of this family found in these beds are of the *costalis* type, and I consider there can be little doubt that they belong to the genus *Atalophlebia*, s.s.

Atalophlebia culleni (Eth. fil. and Olliff), 1890.

(Plate x, figures 1-5.)

Ephemera culleni Etheridge Junr. and Olliff 1890, *Mem. Geol. Surv. N.S.W.*, Pal. 7:8.

Nymph.—The complete structure, excluding the abdominal gills, is known. The description is based largely on four of the specimens figured by Etheridge and Olliff and three additional specimens, one of a juvenile specimen and the others of complete nymphs, one showing clearly the caudal setae.

Nymph of the depressed type with widely flattened femora. Head rectangular, dorso-ventrally depressed, eyes small, situated postero-laterally, protruding slightly at the margin, well separated in the mid-line. Anterior border of clypeus slightly emarginate medianly. Thorax slightly wider than head, insertions of fore legs rather close together, middle and hind well separated, almost at the margin; femora of all legs strongly flattened, only about three times as long as wide, tibiae not strongly flattened, not quite as long as femora, tarsi considerably shorter than tibiae. Wing sheath large in mature nymph, extending to the third segment of the abdomen, mesonotum somewhat convex. Segments of abdomen gradually increasing in length but narrowing in width, so that the ninth is almost as long as wide. Postero-lateral pleural margin of segments produced into a spine, increasing in size over the posterior segments. Three long, fine, caudal cerci, the median, at least, slightly longer than the abdomen.

Length of mature nymph, excluding cerci, about 11 mm.

Type.—Holotype nymph, here designated, D112 (Figure 5 of Etheridge and Olliff) in the Australian Museum. Paratypes D108, D143, D113 + three others, not numbered.

Type Locality and Horizon.—Fox and Partridge's Claim, Red Hill, near Emmaville, New England. Youngest Tertiary Stanniferous lead of the Vegetable Creek Tin-field, Pliocene?

Family Baetidae.

Genus **Cloeon** Leach, 1815.

The small shrimp-like nymphs from these beds are referred provisionally to this genus. The head of the fossil is very small and the cerci quite short.

Cloeon emmavillensis, sp. nov.

(Plate x, figures 6-7.)

Nymph.—Length excluding cerci about 7.5 mm. Head very small, triangular in lateral view, more or less rhomb-shaped from above. Antenna partly preserved, very thin, longer than head in lateral view. Thorax large and humped with large mesonotum and wing-sheath. Legs rather long, very thin, femora only slightly wider than tibiae, longer than tibiae. Segments of abdomen of more or less even size, decreasing in width rather rapidly posteriorly, postero-lateral pleural margins not produced into spines. Cerci three, short, only half the length of the abdomen. Abdominal gills not preserved.

Type.—Holotype nymph, lateral view, D52 (Figure 9 of Etheridge and Olliff) in the Australian Museum. Paratype nymph D115 gives the dorsal view.

Type Locality and Horizon.—Fox and Partridge's Claim, Red Hill, near Emmaville, New England. Youngest Tertiary Stanniferous lead of the Vegetable Creek Tin-field, Pliocene?

Reference.

Etheridge, R., Junr. and A. S. Olliff, 1890.—The Mesozoic and Tertiary Insects of New South Wales. *Mem. Geol. Surv. N.S.W.* Pal. 7.

Explanation of Plate x.

All figures x4 *ca.*

1. *Atalophlebia culleni* (Eth. fil. & Olliff), holotype nymph. 2–4. *Atalophlebia culleni*, nymphs. 5. *Atalophlebia culleni*, very juvenile nymph. 6. *Cloeon ? emmavillensis*, sp. nov., holotype nymph. 7. *Cloeon ? emmavillensis*, sp. nov. nymph.

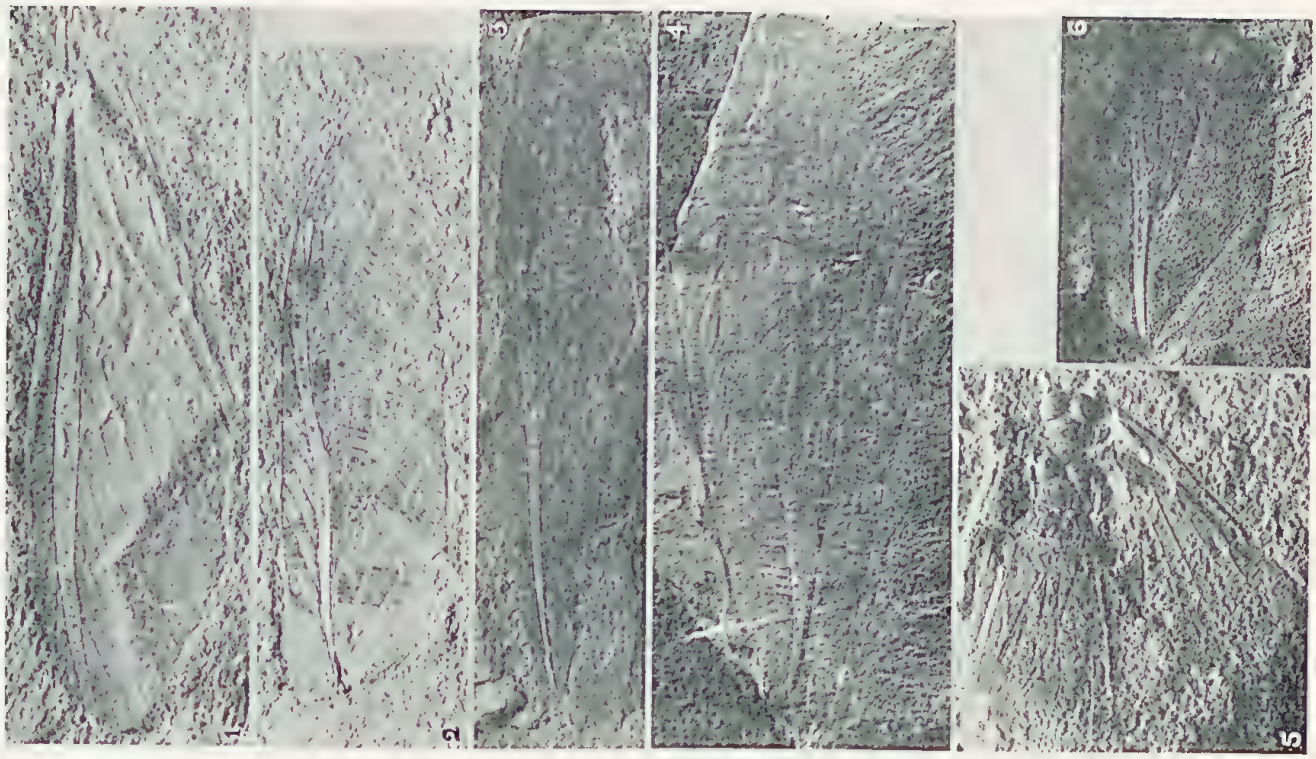

PLATE XI.

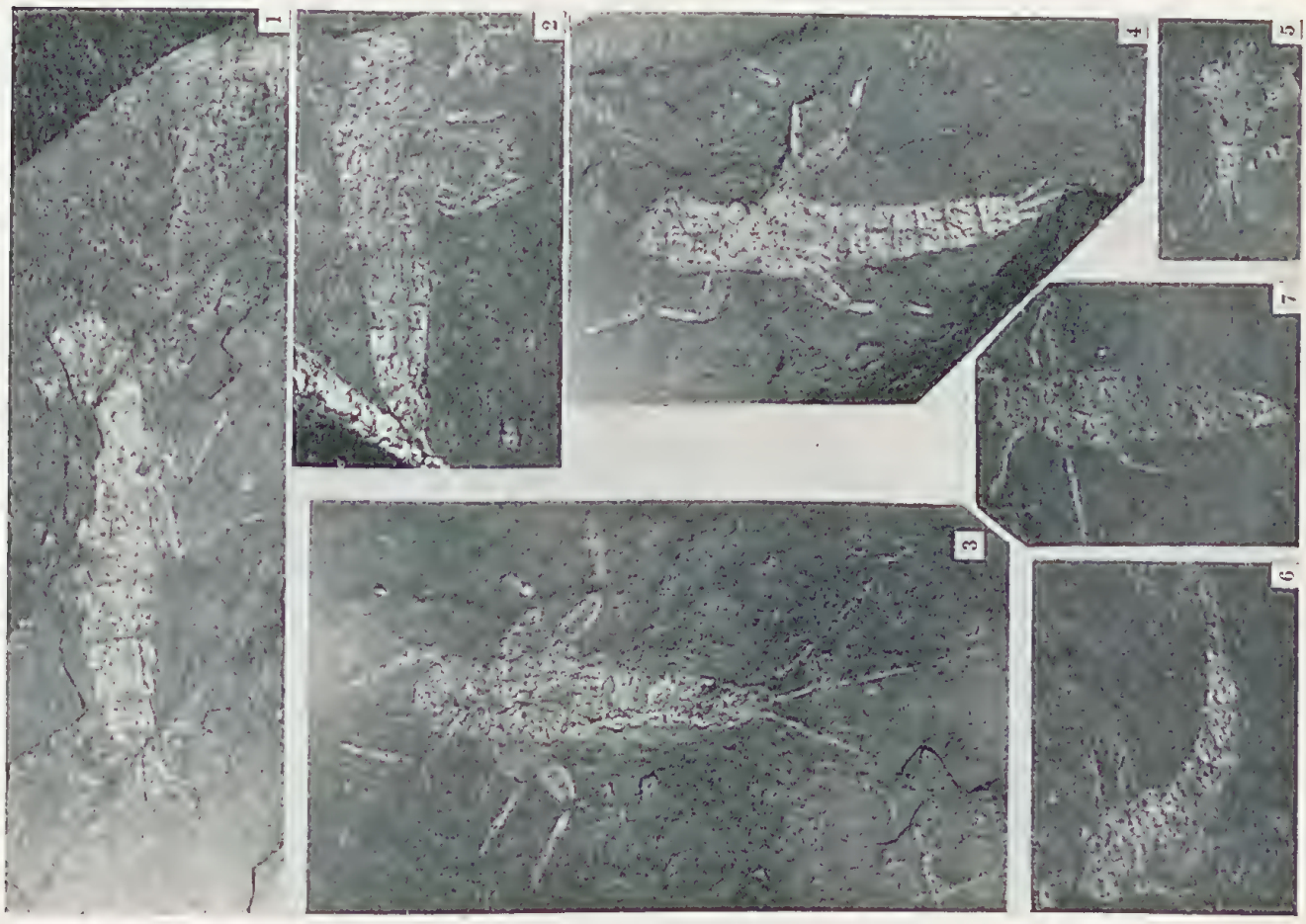

PLATE X.

FURTHER TRIASSIC INSECTS FROM BROOKVALE, N.S.W. (ORDERS ORTHOPTERA SALTATORIA, PROTORTHOPTERA, PERLARIA.)

By E. F. Riek.

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(Plate xi; text-figures 1-5.)

An earlier paper on the fossil insects of this series dealt with the Mecoptera, while this paper covers the remainder of the insects, with the exclusion of the Homoptera-Copeognatha and Blattaria and some doubtful fragments.

As with the Mecoptera, some of the specimens are beautifully preserved, notably the forewing of *Prohagla superba,* which shows clearly the wing pigmentation pattern.

The Orthopteroid fauna is dominated by the very large and highly modified *Clathrotitan* which, although considered within the Orthoptera Saltatoria, has a most curious stridulatory apparatus. It is very interesting also to record two quite distinct Protorthoptera from Triassic strata. Perlaria are recorded from the Upper Permian strata of Belmont, so it is not surprising to find them in this Triassic fauna, particularly as these two localities are less than one hundred miles apart.

Order Protorthoptera.

Family Idelidae Zalessky.

Protorthoptera with an enlarged, arched Cu and more or less straight anal veins.

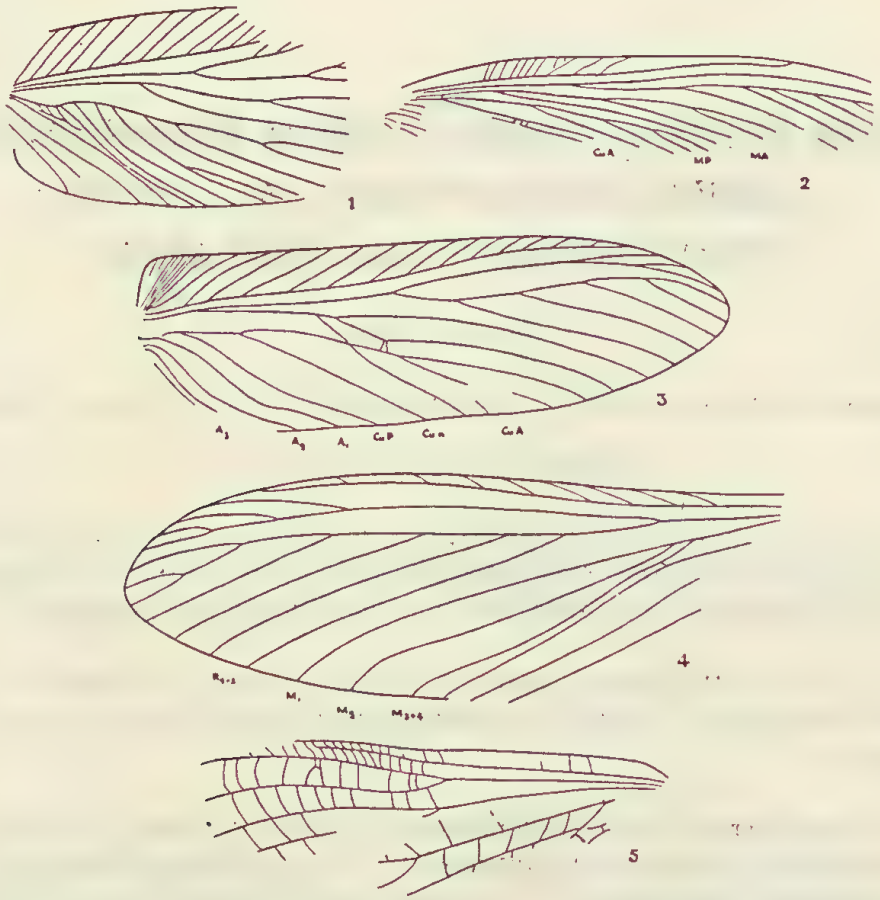
Genus **Austroidelia** nov.

Genotype, *Austroidelia perplexa,* sp. nov.

Forewing.—Resembling *Metidelia* Martynov, 1937, from the Russian Permian but differing in the shorter anal veins and more angled base of Cu.

Sc with numerous anterior branches; Rs arising towards the base of the wing; M forking before the origin of Rs with MA, forked at least once and MP apparently simple, CuA large, strongly sigmoidally curved near base, giving off a large series

of pectinate branches on the lower side, the proximal three or four short and not reaching the wing margin; CuP straight, simple, forming a "vena dividens"; anals short, straight, slightly divergent.



FIGURES 1–5

1. F. 39179, holotype of *Austroidelia perplexa*, sp. nov., x 2·25 *ca.*; 2. F. 30970, holotype of *Mesacridites elongata* x 1 *ca.*; 3. F. 38264, holotype forewing of *Prohagla superba*, sp. nov., x 1·5 *ca.*; 4. F. 41290, hindwing of *Prohagla superba*, x 2·25 *ca.*; 5. F. 35877, holotype of *Mesonotoperla sinuata*, x 4·5 *ca.*

Austroidelia perplexa, sp. nov.

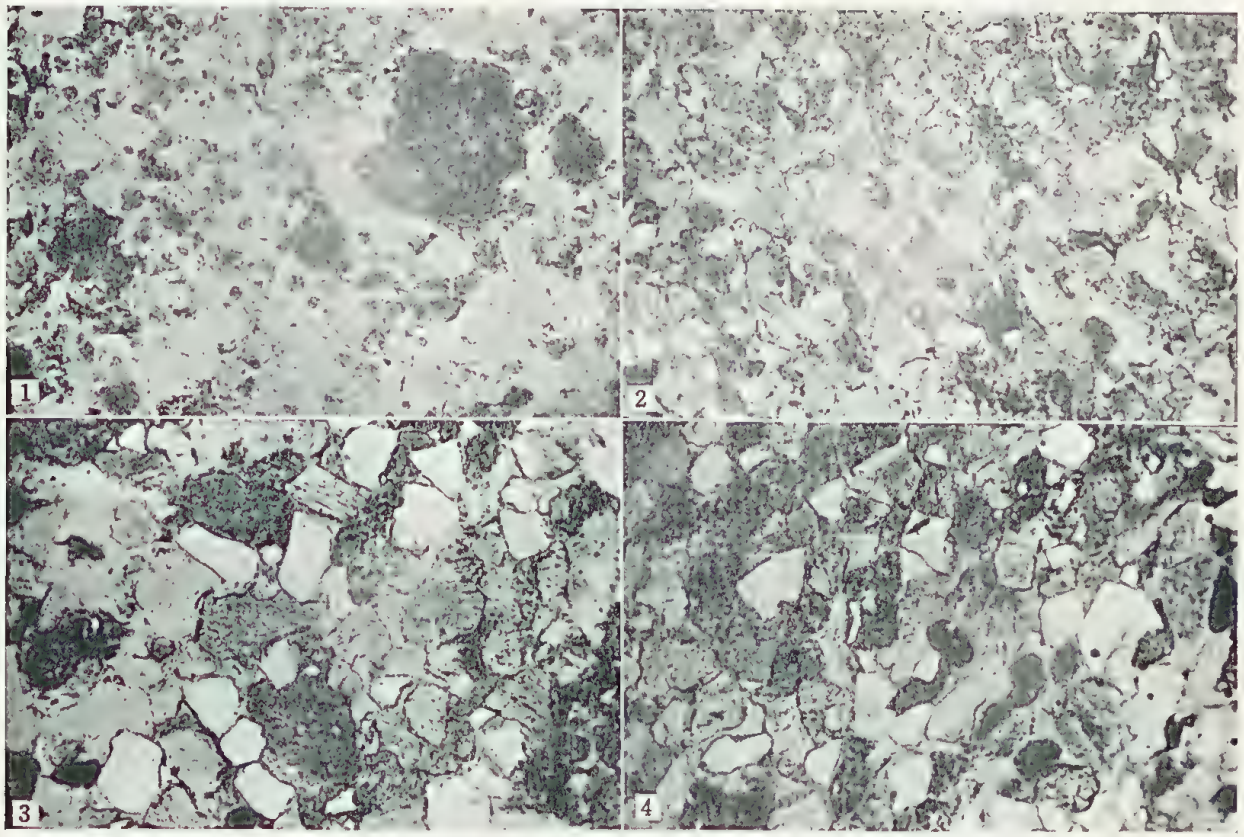
(Plate xi, figure 6; text-figure 1.)

Forewing.—Apical third and extreme base not preserved; costal space rather wide; Sc with numerous, oblique veinlets to the costal margins, apex not preserved; Rs arising in the basal half with at least three branches preserved; M arising from base, branching into MA and MP somewhat before the origin of Rs, with MA forking at least once and MP apparently simple; Cu occupying a large portion of the wing, CuA strongly sigmoidally curved near the base, giving off a large series of at least ten pectinate branches on its lower side, the basal ones closely spaced and the basal three or four not reaching the wing margin, those immediately following curving towards CuP, apical branching quite open; CuP a rather short, simple, strong straight vein; anals straight, 1A almost parallel to CuP, succeeding ones shorter, diverging slightly from one another. Archedictyon very reticulate with some straighter cross-veins between Sc and R_1.

Length of holotype fragment 17 mm. indicating a total length of about 26 mm.; greatest width 9 mm.

Type.—Holotype forewing F.39179 and counterpart F.39190 in the Australian Museum Collection.

Type Locality.—Beacon Hill, Brookvale, New South Wales.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Horizon.—Lenticular shale, Hawkesbury Sandstone Series, Triassic.

This species is considered to be a Protorthopteron which are more typical of Permian and Upper Carboniferous than of Triassic strata.

Family Stenaropodidae Handlirsch.

Protorthoptera with both M and Cu well branched and with marked fusion between MP and CuA_1.

This family is more typical of Palaeozoic strata but a new genus is described from these Triassic beds.

Genus **Mesacridites** nov.

Genotype, *Mesacridites elongata,* sp. nov.

Forewing.—Similar to *Permacridites* Martynov from the Permian of Russia but with less expanded costal area, shorter Sc and less angling at the fusion of MP and CuA_1. Anal veins and portion of Cu not preserved; Sc ending well before the apex; R_1 apparently simple and Rs with numerous pectinate branches.

Mesacridites elongata, sp. nov.

(Plate xi, figure 3; text-figure 2.)

Forewing.—Sc long, gently sigmoidally curved, extending into the apical third of the wing, a complete series of costal veinlets, mostly simple but occasionally forked or anastomosed; R_1 almost parallel to Sc, closest at base, apparently simple; Rs arising near the basal third of the wing, with a series of pectinate branches (six preserved, possibly three more), all branches long and simple; M arising from the base of the wing, forking early, MA four-branched, pectinate, first forking obscure but before the origin of Rs, the other two after it; MP fused almost immediately to CuA_1, apical free portion not clearly demarcated, either simple or with an apical fork; Cu only partially preserved, CuA with at least three branches; cross-veins not well preserved.

Length of preserved portion 55 mm. indicating a wing length of about 65 mm.

Type.—Holotype F.30970 in the Australian Museum Collection.

Type Locality.—Beacon Hill, Brookvale.

Order Orthoptera Saltatoria.

Suborder Ensifera.

Superfamily Gryllacridoidea.

Family Prophalangopsidae Zeuner, 1935.

This is one of the most primitive families of the Ensifera and is probably ancestral to all families, with the possible exception of the Gryllacrididae.

The family is well represented in the Jurassic and persists with three Recent species belonging to two genera. Only one of the nine fossil genera (excluding the Geinitziidae) is recorded from the Triassic. A new genus *Prohagla,* considered the most primitive representative of the family, is described from these Triassic beds. This genus is placed in the new subfamily Prohaglinae. *Notopamphagopsis,* from the Triassic of South America, is considered to belong to this new subfamily. The subfamily Haglinae then contains only the genus *Hagla* from the Lias of England. In this genus both sexes have been recognized. The subfamilies Cyrtophyllitinae and Prophalangopsinae contain species with more specialized wings, with the two Recent genera included in the latter subfamily.

Subfamily Prohaglinae nov.

Forewing of the male similar to that of the Haglinae, but without the strongly curved MA_1; anals only slightly curved and 1A not thickened. However, there is sexual dimorphism in the shape of the anal veins. They are longer and straighter in the female. The new genus *Prohagla* is considered to belong to the Prophalangopsiidae because of this sexual dimorphism. The female, at least, could almost as readily be placed in the Gryllacrididae. *Notopamphagopsis* Cabrera 1928 from the Triassic of South America, although very imperfectly known, is removed from the Haglinae and considered in this subfamily.

Genus **Prohagla** nov.

Genotype, *Prohagla superba*, sp. nov.

The genus shows a close affinity to *Hagla* but there is practically no stridulatory modification in the male. The hindwing differs very little from that of *Pamphagopsis maculata* Martynov, 1925, except for the more primitive branching of R_{1+2}. The genus can be compared with the most primitive Gryllacrididae such as *Palaeorhenia*, particularly *P. scotica* Zeuner from the early Tertiary of Scotland.

Prohagla retains the very primitive features of a long Sc, reduced branching of R_1 and gently curved anals. It is more specialized than the Palaeozoic Sthenaropodidae in having only a two-branched MA, reduced fusion between MP and Cu and in having the anals gently sigmoid instead of slightly arched. It also exhibits sexual dimorphism which allies it to the Prophalangopsiidae. *Palaeorhenia* shows a more advanced condition with shortened Sc, many branched R_1, less fusion between MP and Cu and longer anals running parallel to the hind margin for some distance.

Forewing.—Male: Costal vein with a number of weak branches in the expanded base of the costal space; Sc extending well towards the apex and with numerous anterior branches which shorten rapidly to the apex; R_1 with limited anterior branches to the wing margin; Rs arising at the middle of the wing, with a number of pectinate branches; M three-branched, forking early, with MP fused to CuA for a short distance and MA two-branched, with MA_1 not sigmoidally curved; CuA_1 with a number of branches (three in the genotypic species); CuA_2 long and straight; CuP arched away from CuA_2, simple; anals simple, gently curved, rather transverse to the wing. Female forewing differs in the more oblique anals and straighter CuP.

Hindwing.—Differs from the forewing in the narrow costal space, no distinct costal vein, three-branched media with MP connected to CuA by a cross-vein and with Cu and anals apparently branching from base.

Prohagla superba, sp. nov.

(Plate xi, figures 1-2; text-figures 3-4.)

Forewing.—Wing of rather large size, strongly expanded at base and with apex rather rounded, costal space strongly expanded over basal half, markedly narrow towards apex; costal vein represented by several (seven or more) weak branches radiating from the base of the wing; Sc long, reaching to the apical fifth of the wing, with numerous, simple, oblique branches to the anterior border; R_1 sigmoidally curved, parallel to Sc for most of its length, near apex giving off anteriorly a series of three oblique branches to the wing margin, ending only very slightly before the apex of the wing; Rs arising at the middle of the wing, with a series of five pectinate branches, all branches long; M arising from R very close to the base, three-branched, forking early, before the origin of Rs and with MP near its origin fused to CuA for

some distance, MA two-branched, with MA_1 gently convex and not sigmoidally curved over its basal quarter with CuP arising close to the base and curved away from CuA in the male but less so in the female; CuA_1 three-branched, CuA_2 long and straight, CuP simple; three simple, curved anal veins preserved, with indications of a smaller fourth vein; cross-veins strong, abundant, mostly simple but between the forks of Rs and MA forming a double-cell structure.

Length of holotype 42 mm., greatest breadth 12 mm. A pigmentation pattern is preserved as illustrated in the plate.

Hindwing.—Wing of rather large size, narrowed at base but expanded somewhat over the apical third; costal vein, if present, very reduced; Sc long as in forewing, with a gentle sigmoidal curvature, with a series of short oblique branches to the anterior margin, R_1 parallel to Sc over its basal half but diverging slightly apically, with three oblique branches to the wing margin from near its apex; Rs arising before the middle of the wing, with a series of six pectinate branches, all branches long and one with a terminal twigging; origin of M obscure, close to the base, three-branched, all branches very long, both forks before the origin of Rs; MP connected from near its origin to CuA by a strong, oblique cross-vein, Cu and anals not clearly preserved but with numerous branches folded on one another and apparently mostly simple from base.

Length of wing 38 mm., width 11 mm.

Type.—Holotype male forewing F.38264 in the Australian Museum Collection. Typical hindwing F.41290.

Type Locality.—Beacon Hill, Brookvale, near Manly, New South Wales.

Horizon.—Lenticular Shale, Hawkesbury Sandstone Series, Triassic.

The holotype is a beautifully preserved, perfect wing showing pigmentation-pattern. The hindwing, also, is very well preserved.

These two wings were associated originally on the structure of the anterior halves of the wings and on their general size. The anterior halves are very similar except for the costal space which is greatly expanded over the basal half (forewing) in one case and very narrow (hindwing) in the other. There is one extra branch and a small twigging on Rs in the hindwing but the number of branches very probably varies with the individual. The media differ to a greater extent with MP connected to CuA only by a cross-vein in the hindwing. The hindwing retains the primitive feature of a distinctly branched media. This also occurs in the Recent *Prophalangopsis.*

More recently an additional specimen, F.43339, has been discovered and it shows an associated fore and hindwing of a female but the forewing lacks the apical half and the hindwing is crumpled behind.

Order Orthoptera Saltatoria.

Suborder Incertae Sedis.

Family Clathrotitanidae.

Mesotitanidae Tillyard, 1925, in part; McKeown, 1937.

The family contains only one genus, *Clathrotitan* McKeown, 1937. The genus *Mesotitan* Tillyard, 1916, is a quite distinct genus most probably referable to the Homoptera. The holotype and only known specimen of the genotype, *giganteus*

Tillyard, 1916, from the Triassic of St. Peters, Sydney, New South Wales, is very badly preserved. Subsequently Tillyard (1925) described *Mesotitan scullyi* from the Brookvale Triassic. McKeown (1937) described additional specimens of *scullyi* and erected the genus *Clathrotitan* for the male with genotype *andersoni* McKeown (= *Mesotitan scullyi* Tillyard, 1925). In the same paper McKeown described *Mesotitan tillyardi,* from a fragmentary specimen, considered to be *scullyi.*

This is a most interesting family in which the male has a remarkable stridulating organ developed from the thickened and expanded cross-veins between Rs, MA and MP. These form a large central disc in the wing. In some respects this reminds one of the more primitive subfamilies of the Prophalangopsiidae, such as the Haglinae, but the structure is different. The female wing is more like that of the Sthenaropodidae of the Upper Carboniferous and Permian.

The family very probably represents a side-branch derived from some Sthenaropodid stock and is not referable to either the Ensifera or the Acridodea, but possibly belongs to a distinct suborder.

Genus **Clathrotitan** McKeown, 1937.

Genotype *Mesotitan scullyi* Tillyard, 1925 (= *Clathrotitan andersoni* McKeown, 1937).

Mesotitan Tillyard, 1916 (in part); McKeown, 1937.—*Clathrotitan* McKeown, 1937.

Forewing.—Wing of very large size, with somewhat pointed apex, rather narrow in female, distinctly expanded in the middle in the male due to the well-developed stridulating organ developed discally from the cross-veins between Rs and MP; Sc very long, reaching almost to the apex of the wing, with numerous costal veinlets, transverse at the base of the wing but becoming progressively more oblique towards the apex; R_1 simple or with slight apical forking, subparallel to Sc; Rs rising rather close to the base of the wing; MA two-branched, MP with a short branch fusing with CuA_1 which is a strong, simple vein, CuA_2 arising towards the base, with a number of pectinate branches to the wing margin, CuP arising from CuA almost at the base of the wing, with limited apical branches; 1A a strong, simple vein, other anals weaker, branched, particularly 2A; cross-veins simple, transverse over most of the wing but forming an irregular archedictyon towards the margin.

Clathrotitan scullyi (Tillyard), 1925.

(Plate xi, figure 4.)

Mesotitan scullyi Tillyard, 1925, *Proc. Linn. Soc. N.S.W.*, 50: 376.—*Clathrotitan andersoni* McKeown, 1937, Rec. Austr. Mus., 20: 32.—*Mesotitan tillyardi* McKeown, 1937, Rec. Austr. Mus., 20: 34.—*Mesotitan scullyi* McKeown, 1937, Rec. Austr. Mus., 20: 35.

Forewing.—Of both sexes was described by McKeown.

Hindwing.—Based on F.43741 Australian Museum Collection. Wing with extreme base and apex missing and costal margin incomplete. Anal fan folded back over the wing. Sc very strong; R forked close to the base, with R_1 arched slightly, Rs forking not before its middle, possibly three-branched, M forking at a level with R, into MA and MP, MA forking again almost immediately and branches running more or less parallel to the wing margin, MP fusing with Cu just after the forking of MA but becoming free after some distance and continuing as a long simple vein to the wing margin, Cu with three distinct branches, CuA_1 forked after the separation

of MP, CuA_2 very close to CuA_1, decidedly concave, three branched near the wing margin, CuP well separated, with a three-branched condition, similar to that on CuA_2, towards the wing margin, 1A rather close to CuP, apparently branched pectinately towards the wing margin, succeeding veins simple till close to the wing margin, anal field somewhat expanded, but no distinct anal-fan.

Type.—The framentary type is in the collection of the Australian Museum, Sydney (No. F.37189). The types of *andersoni* and *tillyardi* are in the Australian Museum and the Geology Department, University of Sydney, respectively.

There are a number of additional specimens in the Australian Museum Collection but they add nothing to our knowledge of this most interesting species.

Order Perlaria.

Family Eusthenidae.

It is with some doubt that the fossil described below is placed in this family. Unfortunately the venation is not complete but cross-veins are well-developed over most of the preserved portions.

Genus **Mesonotoperla** nov.

Genotype, *Mesonotoperla sinuata,* sp. nov.

Rs simple or if forked only so as a terminal twigging; Sc extending well towards the apex of the wing; CuA apparently only two-branched; M two-branched; cross-veins between M and CuA and between CuA and CuP well separated; no cross-veins between R and M over their basal halves.

In the reduced branching of Rs and CuA the genus approaches *Dinotoperla* and other Leptoperlidae but Sc and the costal space and the origin of Rs differ. The genus differs quite markedly from *Stenoperlidium* from the Upper Permian of Belmont, New South Wales.

Mesonotoperla sinuata, sp. nov.

(Plate xi, figure 5; text-figure 5.)

The single specimen of this species shows all four wings attached to the two thoracic segments and also portions of three legs. Unfortunately the two folded hindwings and one forewing overlie one another and so the venation is very obscure. The other forewing is out-stretched but it lacks most of the anals and the posterior border. The scuta of both meso and meta thorax, which are longer than wide, show an antero-lateral pair of large rounded protuberances. The first two abdominal segments are visible; they are wider than the scutum and wider than long. The preserved portions of the legs show no distinctive features.

Forewing.—Sc long, extending into the apical quarter of the wing, costal space with a complete series of costal veinlets, very close together over its apical quarter; R_1 long, extending almost to the apex of the wing, strongly curved near its apex, giving off over its apical half a close series of cross-veins to Sc and to the wing margin beyond the end of Sc; Rs arising from slightly beyond the middle of the wing, strongly curved parallel to R_1, simple or, if branched, with only a very small end-twigging, spaced cross-veins to R_1 over its whole length; origin of M from base of wing, two-branched, branching at a level of the origin of Rs, branches not as strongly curved as Rs, a series of cross-veins from the forking to Rs but none to R; Cu arising from base, quickly forking, with CuP curved away from CuA for a short distance and then continuing

almost parallel to it, CuA two-branched near apex, if a third branch is present on CuA it is very small; CuP simple, a complete series of cross-veins between CuA and CuP but between CuA and M cross-veins are only obvious after the forking of M; a cubito-median cross-vein from CuA almost at its origin to M; 1A arising from base, very close to CuP near its origin, rest of vein obscured, a number of cross-veins from CuP to 1A at the middle of its length, 2A preserved only at the cross-vein to 1A at the level of the origin of CuP, and there 2A is strongly angled.

Hindwing.—Very crumpled and imperfectly preserved. R_1 strong, Rs appears to arise from the base or close to the base of the wing, connected to R_1 by strong cross-veins.

Type.—Holotype specimen E. 35877 and counterpart F. 35955 in the Australian Museum Collection.

Type Locality.—Beacon Hill, Brookvale.

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EXPLANATION OF PLATE XI.

1. *Prohagla superba*, gen. et sp. nov., hindwing, F. 41290, x 2 *ca.*; 2. *Prohagla superba*, gen. et. sp. nov., holotype forewing, F. 38264, x 1·6 *ca.*; 3. *Mesacridites elongata*, gen. et. sp. nov., holotype, F. 30970, x 1·6 *ca.*; 4. *Clathrotitan scullyi* (Tillyard), hindwing, F. 43741, x 0·8 *ca.*; 5, *Mesonotoperla sinuata*, gen. et sp. nov., holotype, F. 35877, x 2·4 *ca.*; 6. *Austroidelia perplexa*, gen. et sp. nov., holotype, F. 39179, x 2 *ca.*

THE STRATIGRAPHY OF THE WIANAMATTA GROUP TRIASSIC SYSTEM, SYDNEY BASIN

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(Plate xii, ten text-figures; eight maps.)

Introduction.
Methods of Mapping.
Stratigraphy.
A. General Definition.
B. Liverpool Sub-group : (i) Ashfield Shale; (ii) Minchinbury Sandstone; (iii) Bringelly Shale.
C. Camden Sub-group : (i) Potts Hill Sandstone; (ii) Annan Shale; (iii) Razorback Sandstone; (iv) Picton Formation; (v) Prudhoe Shale.
Sedimentary Petrology and Petrography of the Sandstone Formations.
The Sedimentary Environment and Sedimentary Tectonics.
Post-Depositional Tectonics.

SYNOPSIS.

The Wianamatta Group has been divided into two Sub-groups—The Liverpool Sub-group (lower, approximately 400 feet thick, predominantly shale lithology) and the Camden Sub-group (upper, approximately 350 feet thick, sandstone lithology prominent with shale). The Liverpool Sub-group includes three formations (Ashfield Shale, Minchinbury Sandstone, Bringelly Shale). The Camden Sub-group includes five formations (Potts Hill Sandstone, Annan Shale, Razorback Sandstone, Picton Formation, Prudhoe Shale).

The sedimentary petrology of the graywacke-type sandstones and the relation of the lithology to the sedimentary environment and tectonics is discussed. A new element, the *environtope*, is defined to be used with the elements lithotope and tectotope (Krumbein and Sloss, 1951) to describe a lithologic sequence.

Post-depositional tectonics are briefly discussed and a new series of tectonic features described from the south-western suburbs of Sydney.

INTRODUCTION.

The sequence of rocks forming what has become known as the Wianamatta Group of the Triassic System in the Sydney Basin has long been neglected by local workers. Osborne (1948) pointed out the general lack of information on the local Triassic sequence and this first stimulated the writer to complete the present work.

In essence, the problem was to study the outcrop of the Wianamatta Group and determine if consistent and definite divisions could be made on lithologic grounds—divisions that had previously and commonly been regarded as unmappable. Fieldwork, together with interpretation of the available bore data, has shown that consistent and mappable divisions can be made.

It is hoped, and it already seems likely, that this work will be of some practical value to officers of the many Public Utilities who are directly concerned with the nature of the rock type of the Sydney Basin.

The completion of this work is directly due to the willing assistance of many people—too many to mention individually. Professor Marshall, the staff of the Department of Geology of the University of Sydney, and Dr. H. G. Raggatt figured in many helpful discussions; invaluable practical assistance was given by officers of the Joint Coal Board, Metropolitan Water, Sewerage and Drainage Board, Department of Main Roads, Geological Survey and others; Mr. K. Malcolm gave valuable information from his work on the Moss Vale sheet. The completion of the work would have been impossible without the co-operation of Dr. A. B. Walkom and Mr. R. O. Chalmers of the Australian Museum. A research grant awarded by A.N.Z.A.A.S. towards publication of the maps is gratefully acknowledged.

Review of Literature.

Hanlon, Joplin and Noakes (1952) have given a review of the literature but further search has shown amendments necessary and a fuller outline is given here.

The first reference to the rocks now defined as the Wianamatta Group was by Jukes (1847):—"From Parramatta by Liverpool to Campbell Town the country is low, gently undulating and composed almost entirely of black and brown shales, with a few thin inter-stratified beds of sandstone in their lower portion."

Jukes recognized the stratigraphical position as lying above the "Sydney Sandstone" (i.e., Hawkesbury Sandstone) and gave the thickness as at least 300 feet but probably more.

In the following year Clarke noted further information on these rocks and used, for the first time, the term "Wianamatta Rocks".

Clarke, in various publications between 1848 and 1870, referred in passing to the "Wianamatta beds" but in 1870 he further described the sequence and gave the thickness between 800 and 900 feet. His last description in 1878 was used by Hanlon *et al.* (1952) as the definition of the Wianamatta Group:—"The Hawkesbury Rocks are succeeded by another group or series of strata named by me from Wianamatta, or South Creek, which runs longitudinally through the basin which fills in the area between surrounding enclosure of the former series . . . The nearest beds of the latter to the underlying Hawkesbury Rocks, are shales which have occasionally filled in hollows previously existing, or contributed patches forming considerable masses as well as thin layers to the uppermost Hawkesbury Rocks . . . The Wianamatta Beds are, however, not all shale, for there are fine sandstones, more compact and heavier than the Hawkesbury, calcareous sandstones and ferruginous nodules, bearing fishes and small fresh-water molluscs . . . There are in the Wianamatta Beds in places columnar and pisolitic ironstone with an abundance of fossil wood, plant impressions and calcareous sandstones, which latter form the highest levels and summits of isolated hills that attain but moderate elevation (1100 to 1300 feet) in the centre or on the outskirts of the basin, which latter is chiefly confined to the heart of the County of Cumberland and part of which Bulbunmatta or Razorback Range and Menangle Sugar Loaf are outlying relics of a once wider extended plateau . . . very small patches of coal occur, but no seams nor any of value have been met with."

Tenison-Woods (1883) disputed this definition and considered ". . . . the shales . . . . . do not lie on the top of the Hawkesbury Sandstone, but are intercalated with it . . . consequently there is no such formation as the Wianamatta". This criticism has never been substantiated and Clarke's definition is now generally accepted.

Nomenclature.—From the term "Wianamatta Beds" used by Clarke, the sequence has been referred to by a confusing array of terms. Various writers up to 1882 referred to "Wianamatta Beds, Formation and Shales" while in that year Wilkinson used "Wianamatta Series". Sussmilch (1911) mentioned the "Wianamatta Stage".

Willan (1923) divided the "Wianamatta formation" into upper, middle and lower stages. Unfortunately the criteria for the divisions were never fully described and although his map of the Sydney District (1925) showed the stages, the work has never been accepted because of some difficulty in reconciling the outcrop with the rather short descriptions:—

Lower Stage: approx. 200 feet of carbonaceous and clay shales with some sandy basal beds.

Middle Stage: approx. 200 feet of thin-bedded sometimes ripple-marked sandstones, lenticular, calcareous, tuffaceous sandstones and interbedded seams of inferior coal up to 3 feet thick.

Upper Stage: 200-300 feet thick. Composed of thick bedded and subdividing bands of medium to coarse sandstone with some tuffaceous material and plant remains, mud breccias and shales.

David (1950) gave a two-fold division of the "Wianamatta Series" based on lithologic grounds but no map was published and the descriptions of the stages are rather sketchy:

Lower Stage: shales . . . particularly near the base, are sometimes carbonaceous and ferruginous, but . . . are commonly grey and aluminous though occasionally sandy . . . a few impure coal seams up to 4½ feet thick and a little argillaceous limestone together with some lenticular beds of acid tuff material. 350 feet thick.

Upper Stage: . . . characterized by a large proportion of calcareous and fine siliceous sandstone in beds ranging from less than 1 foot up to 80 feet in thickness, the remainder of the sequence being made up of shale and shaly sandstone.

In the most recent work, Hanlon *et al.* (1952) have clearly established the Wianamatta as a Group as defined in the Australian Code of Stratigraphic Nomenclature (Raggatt, 1950) "consisting, as it does, mainly of shale and sandstone but neither can be considered the dominant rock type".

In this work it will be shown that a major lithologic division into two sub-groups is valid in the Group while these divisions are in turn capable of division into eight well-defined formations.

Age.—The Wianamatta Group rocks were originally included in the Palaeozoic by Beete Jukes (1847). Clarke, in his earlier writings, considered them as Carboniferous but later recognized their Mesozoic age. Wilkinson (1882) recorded the age as probably Triassic and it seems that this age then became confirmed in the literature.

Willan (1923, 1925) described his Lower and Middle Stages as Upper Triassic but considered the Upper Stage to be probably Jurassic, mainly on Chapman's (1909) determination of foraminifera and ostracoda. These generic and specific identifications are now considered generally to be doubtful (Lovering, 1953) and cannot be used with any certainty as an indication of Jurassic age.

David (1950) stated the fossil evidence shows that the "Wianamatta Series" are Upper Triassic.

It is suggested here that: because of (1) the scant nature of the recorded fossils, and (2) the observation (p. 187) that those described have been confined to a zone less than 100 feet above the Hawkesbury Sandstone, the Upper Triassic age, if substantiated, can only be applied with any degree of positiveness to a very small portion (about 100 feet) of the Group. The overlying sequence, of some 650 feet, may well be included with the Jurassic and so correlated with the sequence in the Clarence River Basin, Great Artesian Basin and other lesser basins in New South Wales—but this is speculation and must remain so until more palaeontological work settles the question. For the purpose of the present work, no finer age definition than Triassic is proposed for the Group.

Methods of Mapping.

The various formations of the Wianamatta Group have major outcrops in some 10 sheets of the inch-to-mile military system (Sydney, Port Hacking, Broken Bay, Windsor, Liverpool, Camden, Mittagong, Wollongong, Moss Vale and Kiama). On present geographic extent, then, the Wianamatta Group is confined to the Cumberland Basin as described by Osborne (1948) from Willan's (1923) work.

The outcrop of isolated remnants of the basal formation (the Ashfield Shale) on the edges of four surrounding sheets (St. Albans, Wallerawang, Katoomba and Burragorang) suggests the extent was originally much greater and probably covered an area at least 90 miles from north to south and 40 miles from east to west, and so related to the sedimentation of the Permo-Triassic Sydney Basin of central eastern New South Wales.

The boundaries with the Hawkesbury Sandstone alone have been shown on the maps. Tertiary igneous intrusions have been shown only where they are in direct association with the Wianamatta Group. These boundaries have been taken from the Bureau of Mineral Resources 4 mile-to-inch geological series Wollongong and Sydney sheets with additional information from the present work.

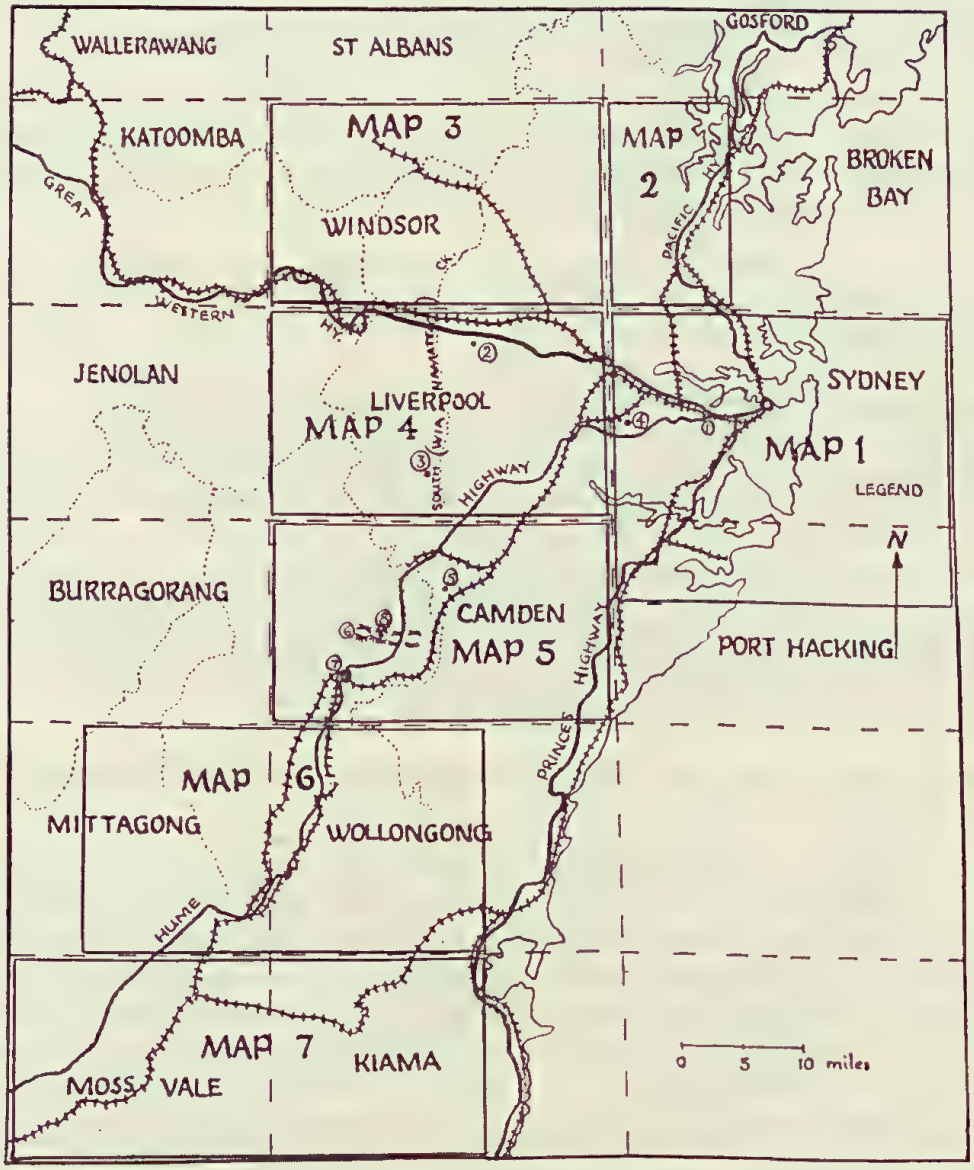

Fig. 1.—Relation of Maps to Military Sheet System Boundary of inch to mile Military Sheet – – – –; boundary of map, ————. Localities of Formational Geographic Names: 1, Ashfield; 2, Minchinbury Trig.; 3, Bringelly; 4, Potts Hill; 5, Mount Annan; 6, Razorback Range; 7, Picton; 8, Mount Prudhoe Trig.

Maps 1-7.

The base maps used in the mapping of the Group were, in general, the inch-to-mile military sheets. For convenience, some of the maps are a combination of two adjacent military sheets where the outcrop area on each is not sufficient to warrant two separate maps. Figure 1 gives the relation of the maps to the military sheet system as well as the localities of the geographic names of the formations. Extraneous information has been kept to a minimum on the maps as it was originally intended that they should be used as overlays on the appropriate military sheet. For this purpose the grid co-ordinates with intervals of 10 were marked on the maps. For publication, however, the maps have been drastically reduced* and the co-ordinates are now only useful as a guide to comparisons with the appropriate military sheet.

In some places (especially on the Moss Vale sheet), areas marked as Ashfield Shale may actually be part of the passage beds with the Hawkesbury Sandstone. Further work is necessary in these areas to determine the exact relations.

For completeness a list of the scattered outliers of shale from the Ashfield Shale is given:

St. Albans Sheet:

(*a*) Thin capping confined to ridge about ½ mile east and west of Bilpin (508605).†

(*b*) Thin capping on Blaxland Ridge (around 720605).

(*c*) Around Mitchell Trig. (813609).

(*d*) Under the basalt cap of Mount Tootie (494648) and extending to Little Tootie (497662).

(*e*) Possible thin capping along the Wheelbarrow Ridge and other high localities. Only the Ashfield Shale would be represented.

Wallerawang Sheet:

Ashfield Shale underlies the basalt of Mount Irvine (447624).

Katoomba Sheet:

(*a*) Thin capping along the line of the Bell road as far as the 420 north-south grid.

(*b*) Under the basalt on Mount Tomah (415549) and Mount King George (Mount Banks, 361497).

Burragorang Sheet:

This sheet has not yet been published. Outcrops are confined to a few scattered remnants along the ridges of the eastern margin of the sheet.

Mapping of the boundaries proved very difficult in most cases due to the considerable soil cover and poor outcrops. The Minchinbury Sandstone, a persistent sandstone formation sandwiched between 400 feet of shale, forms very poor outcrops and is only exposed in road cuttings and quarries. The continuity of extent

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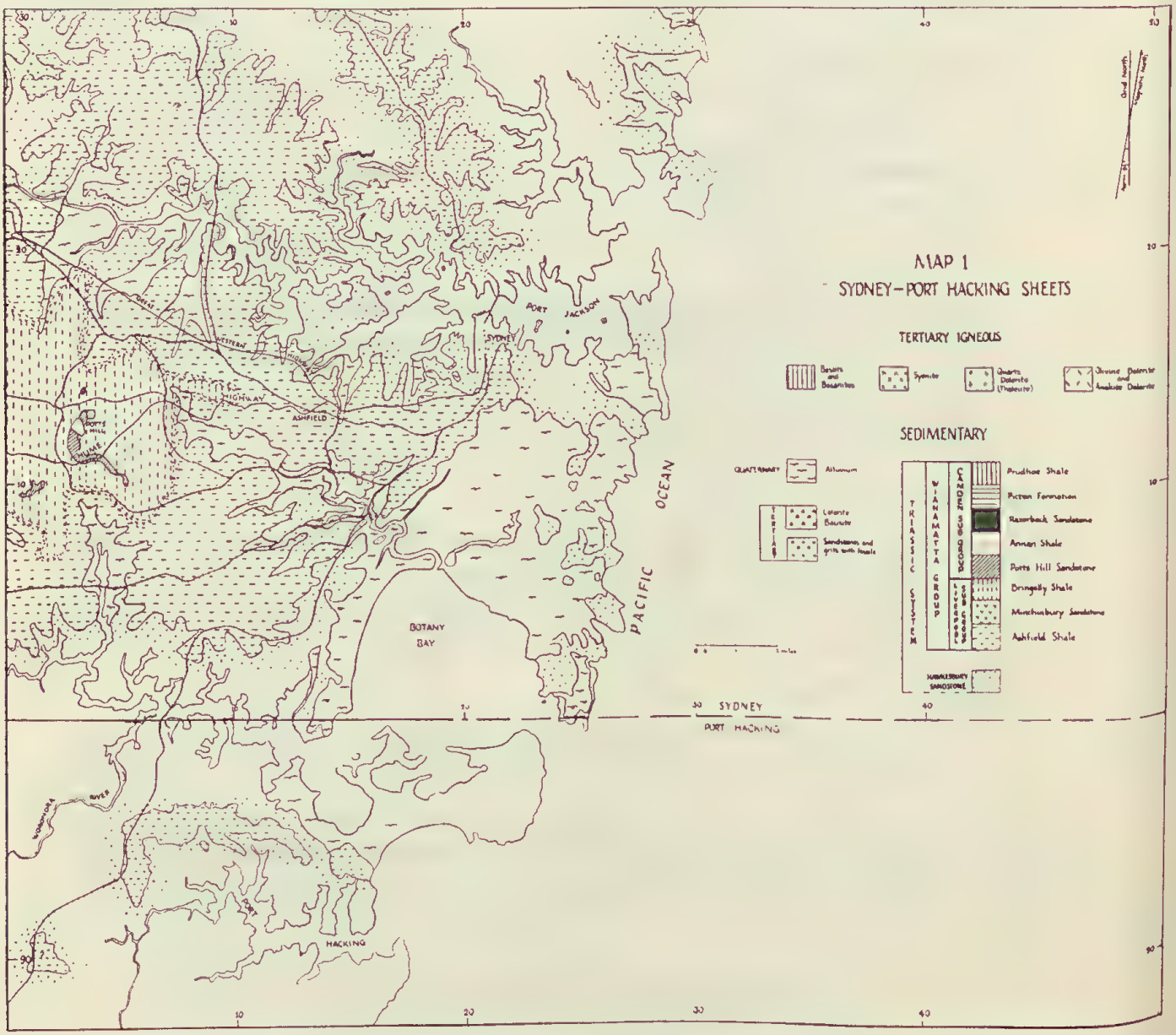
* The originals of these maps, on the scale of 1 mile to the inch, and of figures 8, 9, 10 are filed at the Australian Museum and are available for consultation.

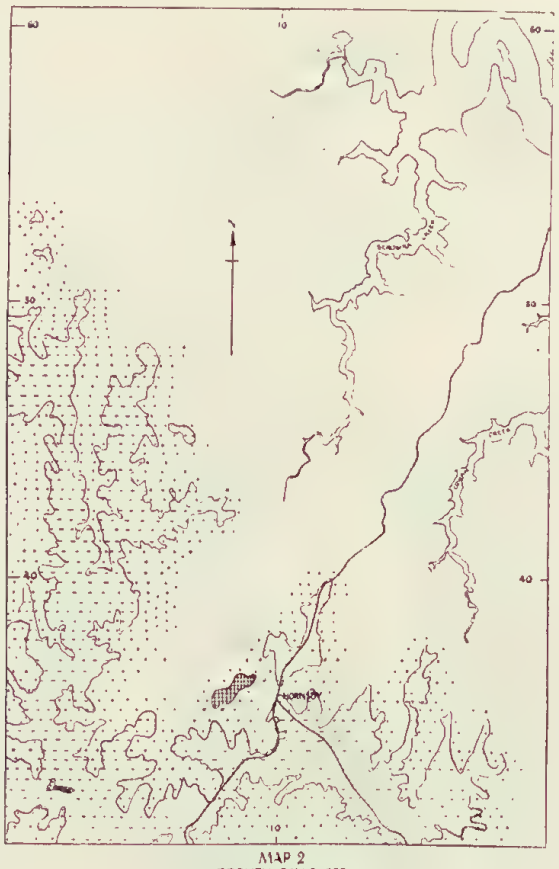
† Numbers in brackets refer to military sheet grid reference.

and the stratigraphic position are quite definite. In general, the boundaries with the Ashfield Shale below and the Bringelly Shale above are shown by broken lines on the map. Unbroken lines are used where the information is more definite.

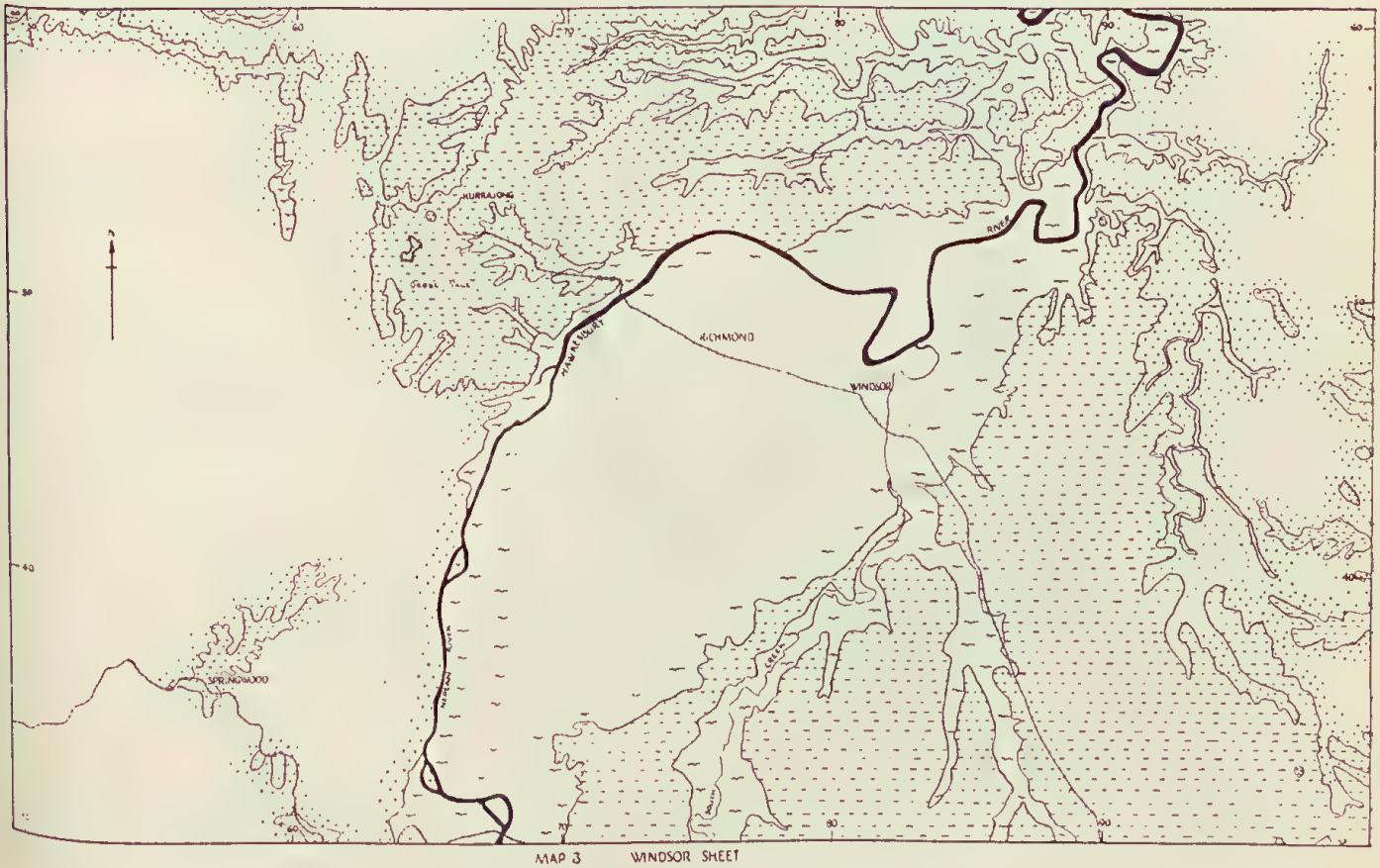
Map 8: Razorback Range.

This map is the type area for the Camden Sub-group. The heavily dissected Razorback Range with its land-slips, thick soil cover and complications due to local warping has previously defied mapping by usual methods, at least in a reasonable time. The outcrop of the various formations was recognized as forming a series of bench levels—the sandstone formations standing out amongst the shales. These levels were the basis for the mapping of the formations since they were readily and accurately plotted on the excellent series of air photos lent by the State Electricity Commission. It is from these photographs that this map is drawn, with frequent ground work for control.

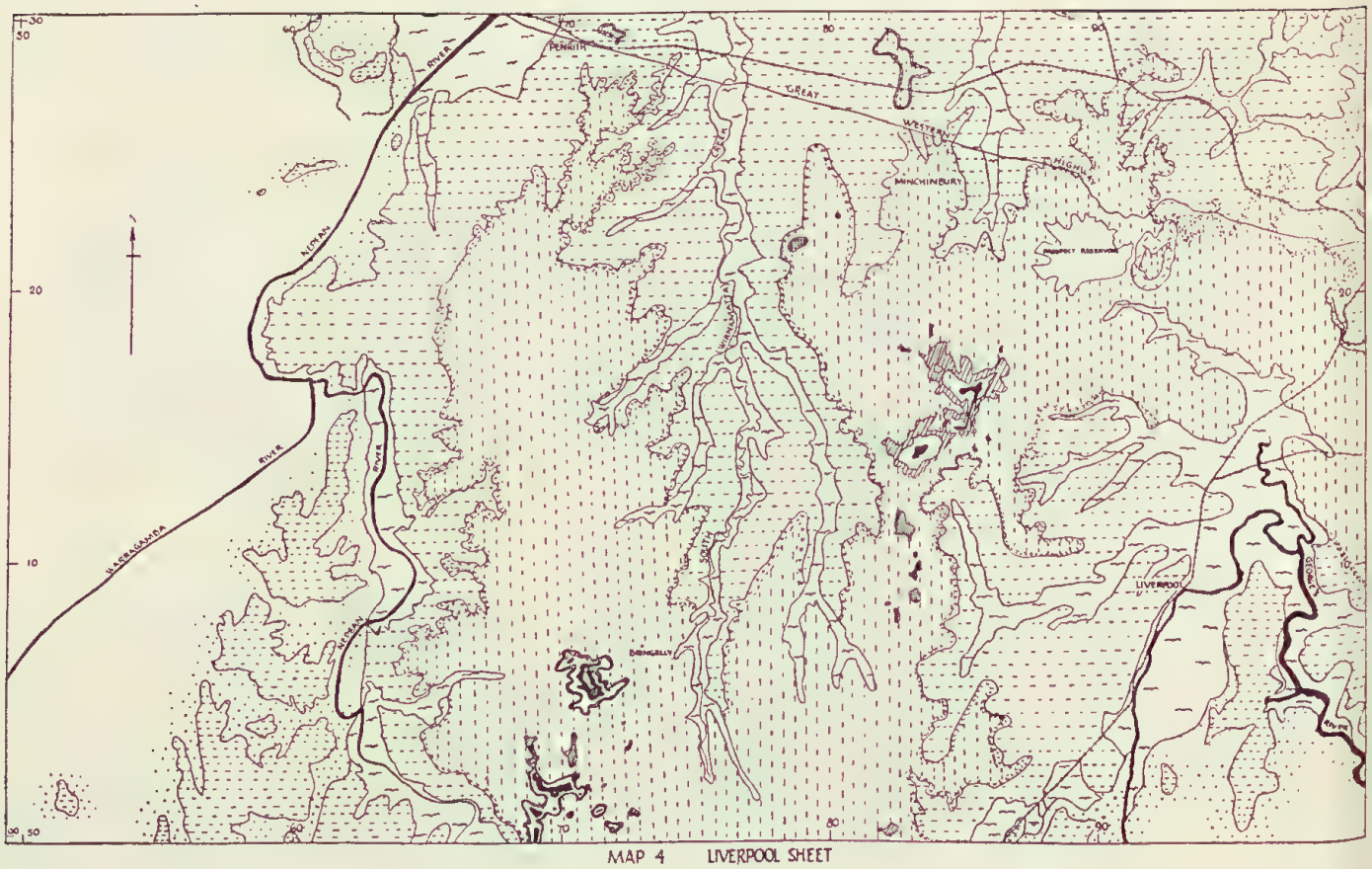




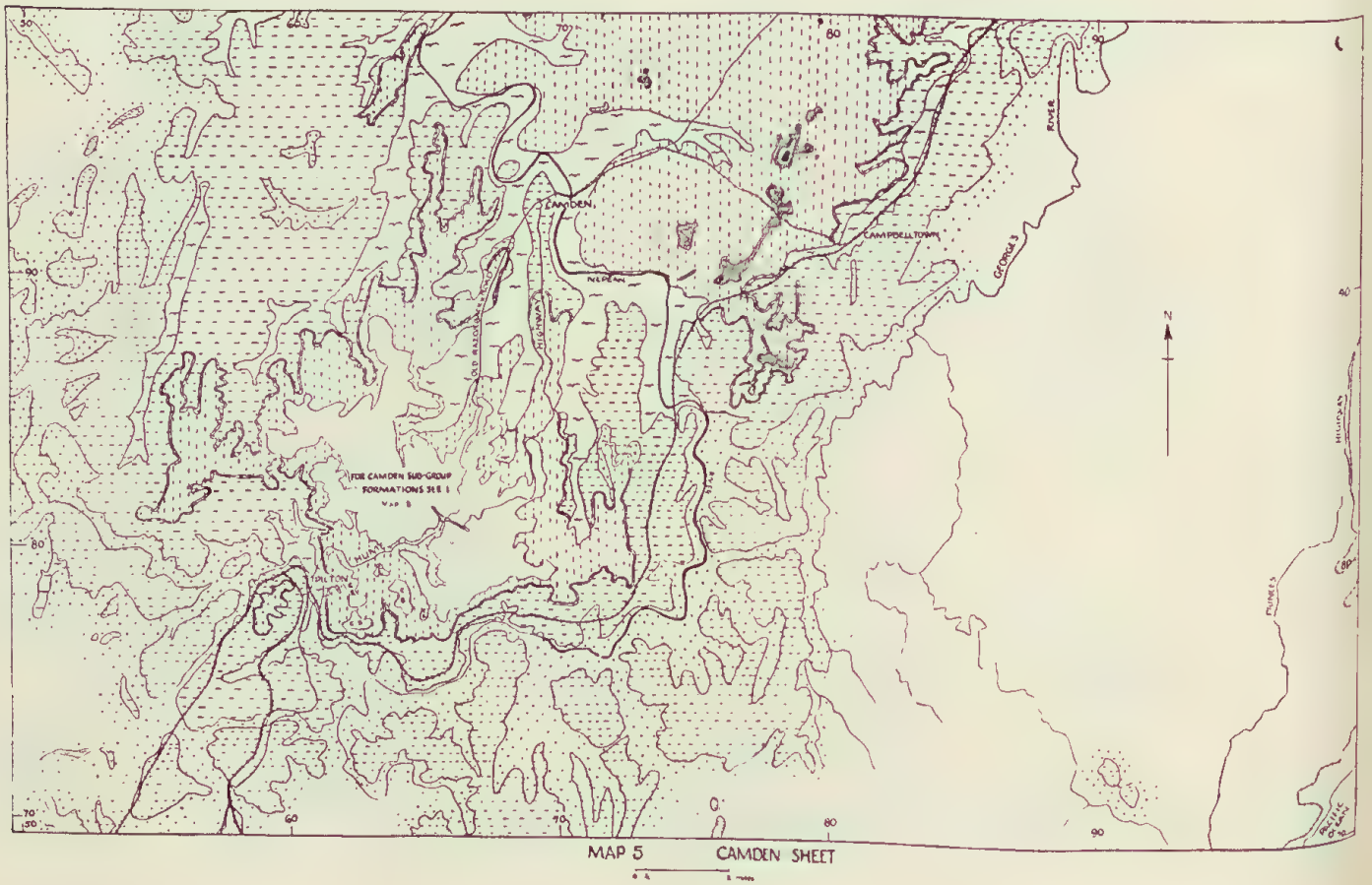
MAP 2
BROKEN BAY SHEET



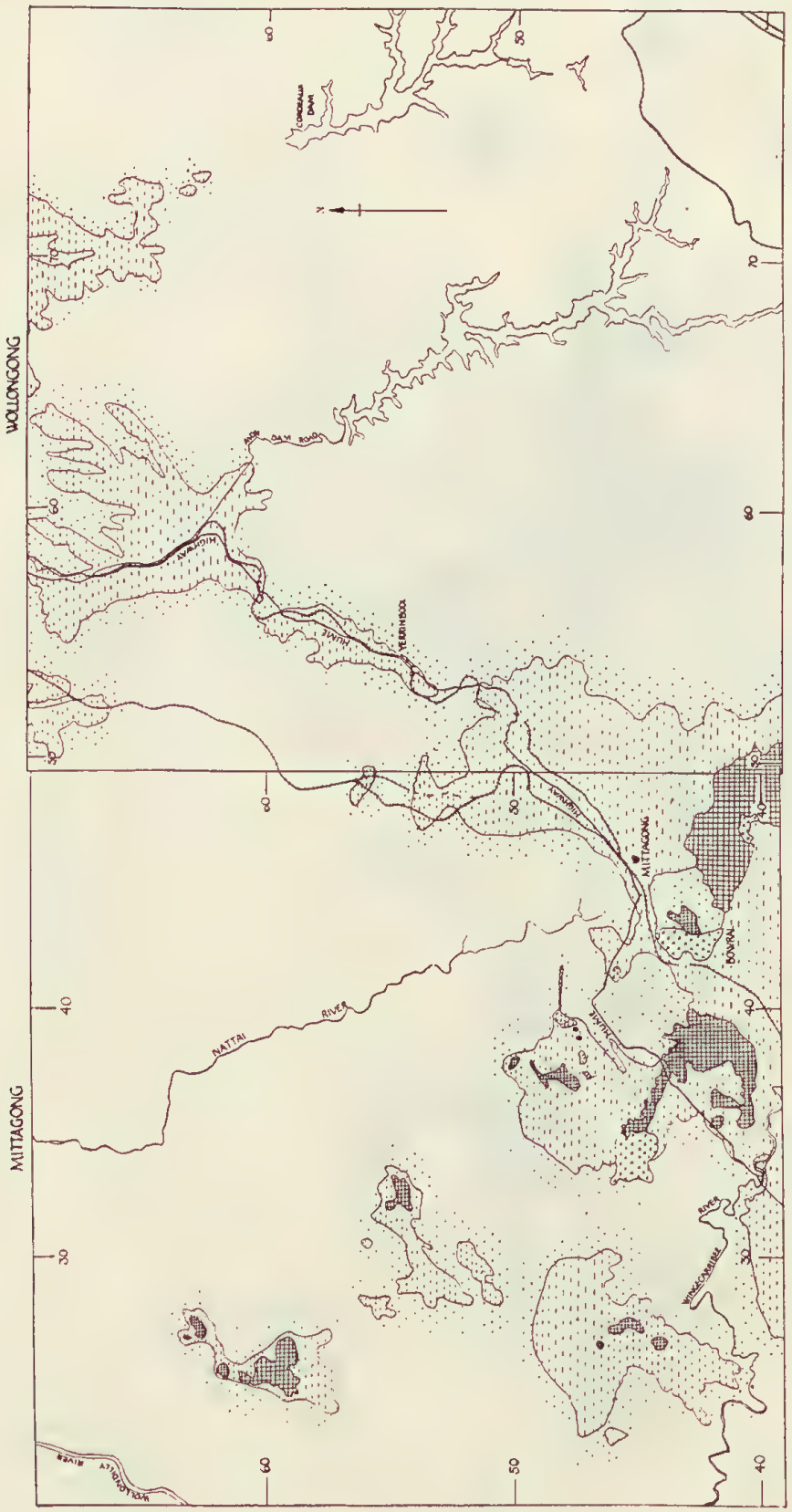
MAP 3 WINDSOR SHEET

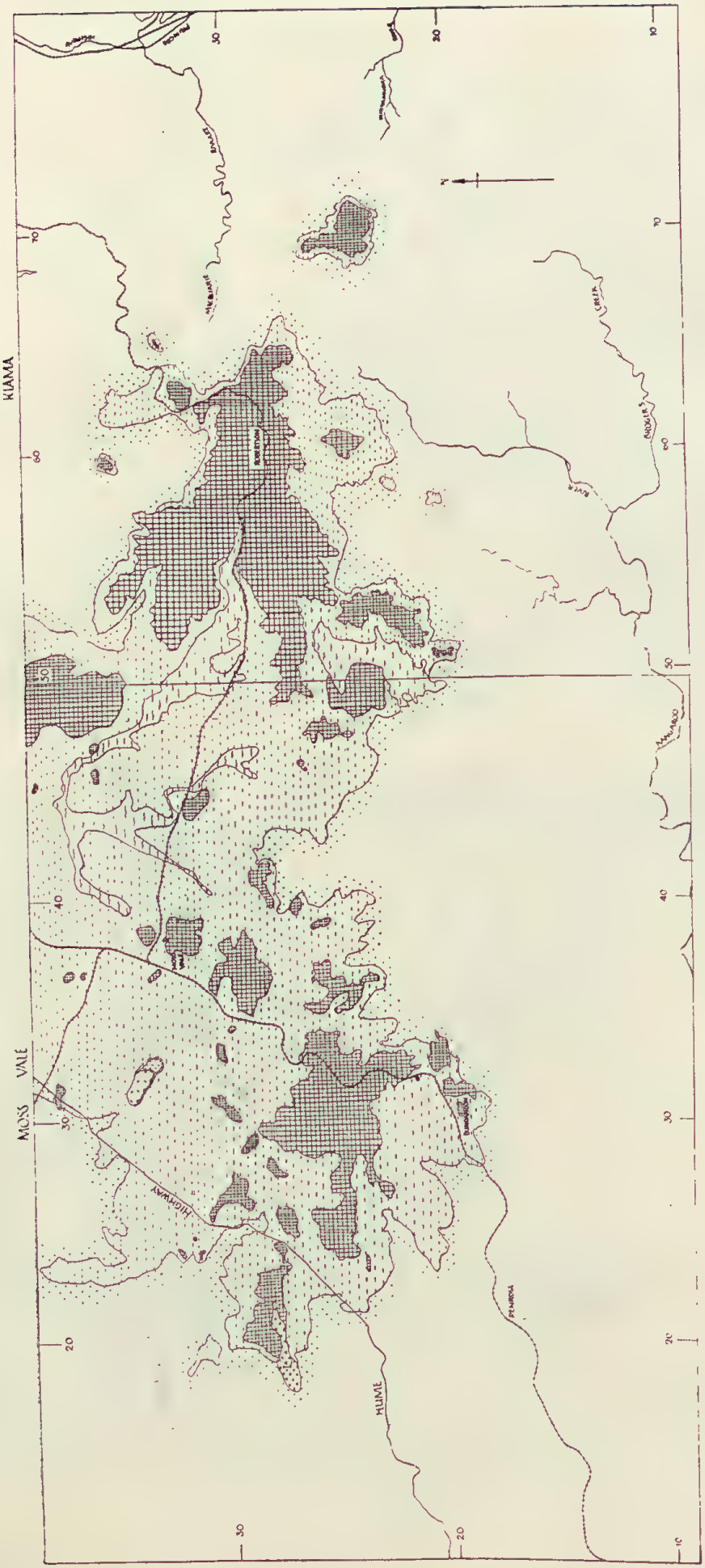


MAP 4 LIVERPOOL SHEET

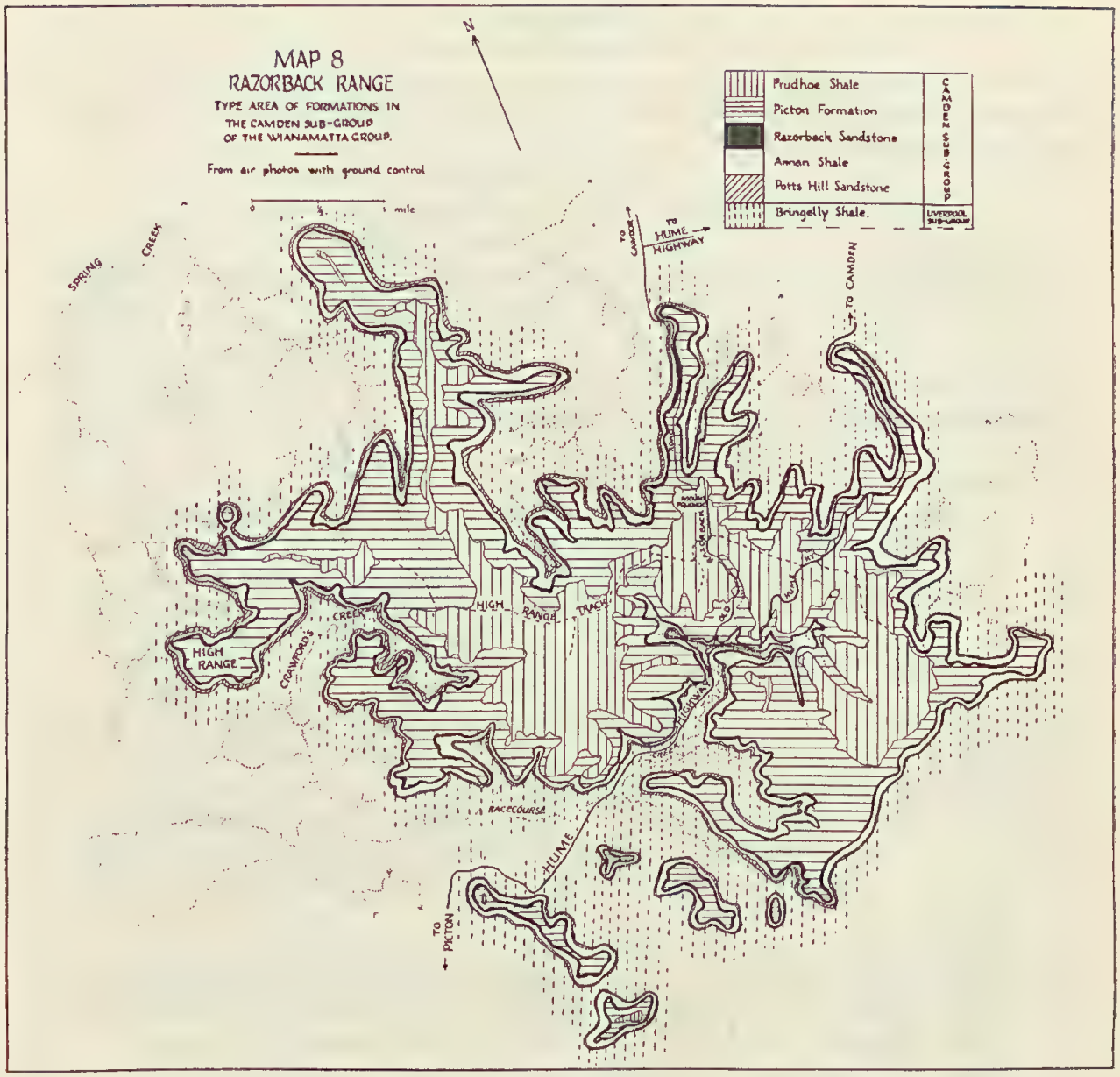


MAP 5 CAMDEN SHEET


WOLLONGONG
MITTAGONG
NATTAI RIVER
MITTAGONG
BOWRAL
YERRINBOOL
MAP 6
MITTAGONG - WOLLONGONG SHEETS


KIAMA
MOSS VALE
HIGHWAY
BOMADERRY
BOMBAY
NOWRA
BERRY
KANGAROO
MUMBULLA
BUNDANOON
MOSS VALE
BERRIMA
MOSS VALE - KIAMA SHEETS

MAP 7


MAP 8
RAZORBACK RANGE
TYPE AREA OF FORMATIONS IN THE CAMDEN SUB-GROUP OF THE WIANAMATTA GROUP.
From air photos with ground control
0 ½ 1 mile
N
Prudhoe Shale
Picton Formation
Razorback Sandstone
Amon Shale
Potts Hill Sandstone
Bringelly Shale.
CAMDEN SUB-GROUP
LIVERPOOL SUB-GROUP
SPRING CREEK
TO CAMDEN
HUME HIGHWAY
TO CAMDEN
HIGH RANGE TRACK
HIGH RANGE
CROWFORDS CREEK
RACECOURSE
HUME HIGHWAY
TO PICTON

Stratigraphy.

General Definition.

The Wianamatta Group has been defined previously as the upper unit in the Triassic System of the Sydney Basin. The sequence of the Triassic System has been given by Hanlon *et al.* (1952) as:

Triassic System
- Wianamatta Group
- Hawkesbury Sandstone
- Narrabeen Group

David's (1950) conception that the Wianamatta Group may be divided into two divisions on lithologic grounds has been discussed above but up to the present time such a division has not been adequately defined and mapped. The first results of the present work indicated that a two-fold division was valid. The boundary is well defined and divides the Group into two distinct lithologic units—the lower, predominantly shale, and the upper, mostly sandstone with some associated shale.

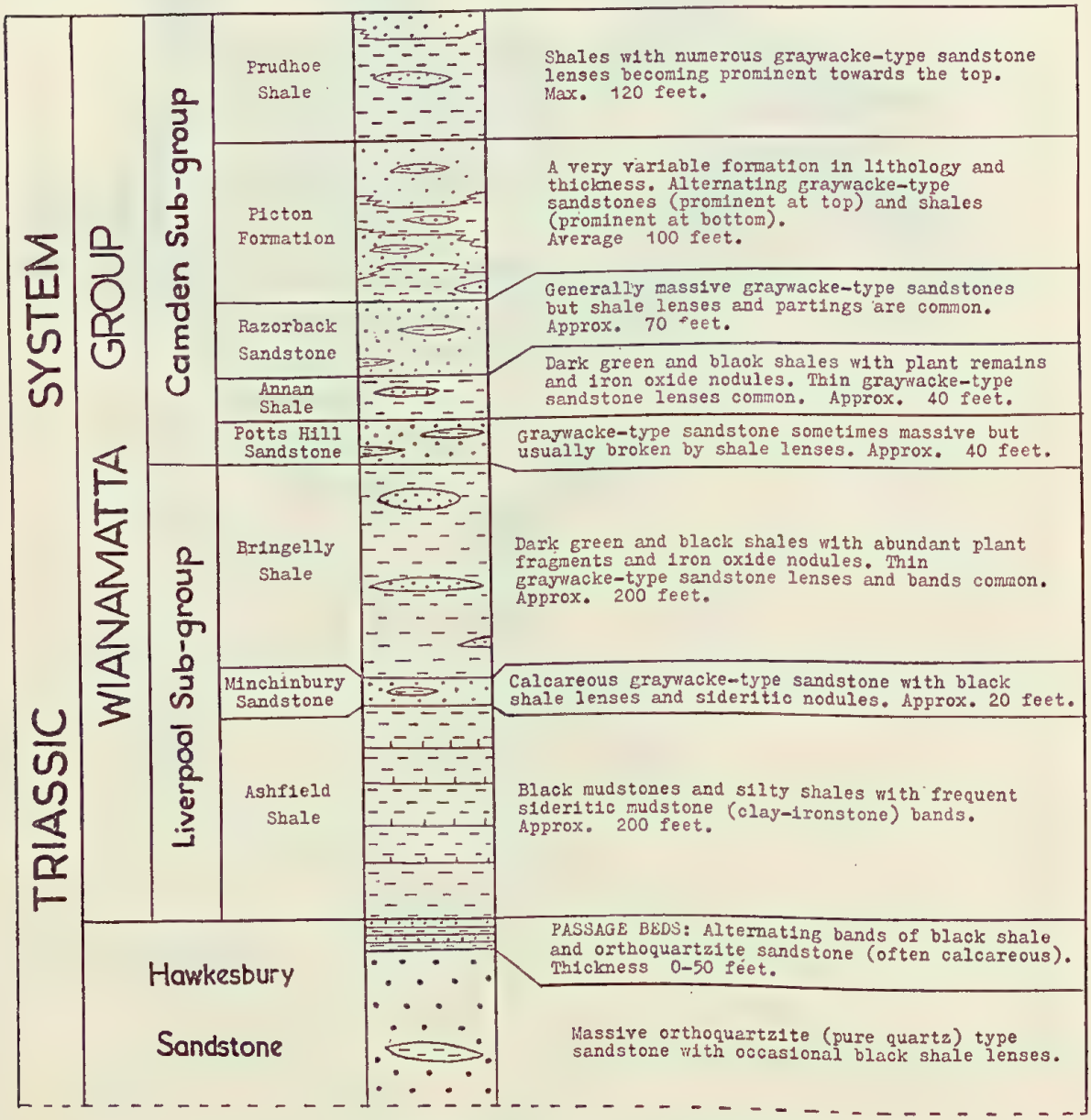

TRIASSIC SYSTEM
WIANAMATTA GROUP
Camden Sub-group
Liverpool Sub-group
Prudhoe Shale
Shales with numerous graywacke-type sandstone lenses becoming prominent towards the top. Max. 120 feet.
Picton Formation
A very variable formation in lithology and thickness. Alternating graywacke-type sandstones (prominent at top) and shales (prominent at bottom). Average 100 feet.
Razorback Sandstone
Generally massive graywacke-type sandstones but shale lenses and partings are common. Approx. 70 feet.
Annan Shale
Dark green and black shales with plant remains and iron oxide nodules. Thin graywacke-type sandstone lenses common. Approx. 40 feet.
Potts Hill Sandstone
Graywacke-type sandstone sometimes massive but usually broken by shale lenses. Approx. 40 feet.
Bringelly Shale
Dark green and black shales with abundant plant fragments and iron oxide nodules. Thin graywacke-type sandstone lenses and bands common. Approx. 200 feet.
Minchinbury Sandstone
Calcareous graywacke-type sandstone with black shale lenses and sideritic nodules. Approx. 20 feet.
Ashfield Shale
Black mudstones and silty shales with frequent sideritic mudstone (clay-ironstone) bands. Approx. 200 feet.
PASSAGE BEDS: Alternating bands of black shale and orthoquartzite sandstone (often calcareous). Thickness 0-50 feet.
Hawkesbury Sandstone
Massive orthoquartzite (pure quartz) type sandstone with occasional black shale lenses.

Fig. 2 Stratigraphic Columnar Section of Wianamatta Group.

Vertical Scale 0 100 feet

This boundary was given to the Bureau of Mineral Resources for their 4 mile-to-inch geological series Wollongong sheet as the Lower and Upper Divisions.

Up till 1953, there was no provision in the Australian Code of Stratigraphic Nomenclature for a term to cover a major subdivision of a Group but in that year the term Sub-group was defined to meet such a need (Raggatt, 1953). At that time, the suggestion was made that the term should be used only if the division intended could not be expressed by using the other terms already provided for in the Code. In the present discussion the eight formations to be defined later are possibly capable of further division into members (although no such division was attempted in this work), so there was no alternative but to define the fundamental two-fold division of the Group with the rank of Sub-groups.

The Liverpool Sub-group.

Definition.—This unit lies immediately above the Hawkesbury Sandstone; the relation with this formation is discussed with the Ashfield Shale. The dominant lithologic type is shale, and two shale formations have been mapped. The thickness is fairly consistent at 400 feet. A centrally-placed sandstone formation some 20 feet thick has also been recognized but it is subsidiary to shale as the main lithologic type.

These shales limit the main agricultural areas of the County of Cumberland and, to some extent, Camden, as well as providing an extremely important raw material for the brick and ceramic industries.

Name.—The Sub-group takes its name from the town of Liverpool, the extreme south-western suburb of Sydney (Liverpool 925090). The name is appropriate by reason of the geographical position of the town—at once adjacent to outcrops of the three component formations.

Type area and section.—The formations of the Liverpool Sub-group cover almost the entire area of outcrop of the Group. Due to the lack of a complete natural section, no type area is given, but the type section is described in the logging of the Potts Hill bores shown in Figures 9 and 10.

The Camden Sub-group.

Definition.—Separated from the Liverpool Sub-group by a massive sandstone formation, this unit is composed of a series of alternating sandstone types and shales, with the sandstones rather more prominent. The thickness is rather variable but has a maximum of approximately 350 feet in the Razorback section.

Name.—The town of Camden (Camden 795932) is appropriate as the geographic name for the upper Sub-group being the town nearest the outcrop of the type section of the Razorback Range.

Type area and section.—Razorback Range is the type area. The type section is shown in Figure 3, a section along the Hume Highway on the south side of Razorback. The geographic extent of the Camden Sub-group is much less than the Liverpool Sub-group and is restricted to Maps 1, 4 and 5.

Map 1.—Sydney-Port Hacking Sheets: The basal formation of the Camden Sub-group has an outcrop confined to a small area around Potts Hill.

Map 4.—Liverpool Sheet: Isolated outcrops only in scattered localities, the more extensive being between Hoxton Park and Cecil Hills and also in the high country to the south-west of Bringelly.

Map 5.—Camden Sheet: Isolated outcrops are to be found in scattered localities —Badgelly Trig., Kenny Hill, Sugarloaf Trig. and others.

The geographic names of formations and Sub-groups have been approved by the New South Wales representatives of the A.N.Z.A.A.S. Standing Committee on Stratigraphic Nomenclature.

The Liverpool Sub-group.

(i) *Ashfield Shale.*

Name.—Ashfield, a suburb of Sydney and a station about 6 miles along the main western railway from Sydney (Sydney 127133), has been taken as the geographic name of this formation, being centrally situated with regard to its outcrop on the Sydney Sheet.

Type Area and Section.—There is no natural section in which the complete formation is exposed, although a number of excellent exposures, usually less than 50 feet, are available in the Sydney District brick quarries. On the other hand there are a number of sub-surface sections available from the bores logged in Figures 9 and 10 and these must serve as the type sections. It is unfortunate that the poor state of preservation of the cores does not allow a more complete lithologic logging to be made.

Lithology and Petrology.—The predominant lithology is shale with varieties such as mudstones and siltstones locally abundant. The sandy types appear to be more common at the top of the sequence especially towards the junction with the Minchinbury Sandstone. Micro-current bedding is very abundant.

The shales are typically black, only showing light colours if weathered. Associated with the black shales, and following a very common association pattern, are bands and lenses of sideritic mudstone (clay-ironstone) very irregular in vertical and horizontal extent but never exceeding 10 inches in thickness. The vertical spacing

TABLE 1.

Partial Analyses of Sideritic Mudstones from the Ashfield Shale.

(Per cent. of sample dried at 105° C.)

	A.	B.	C.	D.
Total ignition loss	25·3	22·9	26·5	25·8
CO_2	24·4	21·6	22·9	25·7
FeO	30·2	24·5	29·7	28·9
Fe_2O_3	4·1	1·1	6·4	2·9
CaO	1·4	n.d.*	2·9	n.d.
MgO	2·2	n.d.	1·5	n.d.
Mn	present	nil.	present	present
SiO_2	present	present	present	present
Ba	nil	nil	nil	nil
$FeCO_3$ (total Fe)	48·7	39·5	47·9	46·6
Fe_2O_3	4·1	1·1	6·4	2·9
$CaCO_3$ (total Ca)	2·5	n.d.	5·2	n.d.
$MgCO_3$ (total Mg)	4·6	n.d.	3·2	n.d.
CO_2 (in excess of above)	2·4	6·6	0·7	8·0
Ignition loss (apart from CO_2)...	0·9	1·3	3·6	0·1
	63·2	48·5	67·0	57·6

A, B.—Ashfield Brick Co. Pit, Milton Street, Ashfield.

C.—Punchbowl Brick and Pipe Co., Bond Street, Punchbowl.

D.—Spear's Brick Pit, Kingsgrove.

*.—Not determined.

Analyst.—Miss M. E. Neilson, C.S.I.R.O. Division of Building Research.

of the bands is also rather irregular but up to 10 bands occur in a 50-feet section. Siderite, in a rather oolitic form, and clay matter are the two main constituents. Partial analyses of four samples of the sideritic mudstone are given in Table 1. Associated with the sideritic mudstones is a suite of minerals (barite, pyrite, marcasite, etc.) partly of authigenic origin. This association of black shales and sideritic mudstone bands is characteristic of "coal measure" type sequences in both Carboniferous and Permian in all parts of the world. It is not surprising, then, that fragments of plants converted to vitrainous material are common in the shale and associated with thin, horizontally restricted lenses of impure coaly material.

TABLE 2.

Analyses of Ashfield Shale.

<100 feet above Hawkesbury Sandstone.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2 ...	61·54	64·26	75·04	67·81	70·70	65·72	65·54	67·74	65·96	59·62	62·77	60·24	58·44	57·04	58·40	64·12
TiO_2 ...	0·48	0·60	0·48	0·56	...	1·10	0·95	0·75	0·64	0·70	2·51*a*	...	...	...	0·80	0·78
Al_2O_3 ...	18·60	22·09	16·82	20·24	19·95	19·26	20·21	19·26	19·10	21·44	20·97	18·96	19·02	16·85	21·10	19·59
Fe_2O_3 ...	6·00	0·50	0·50	0·60	0·35	1·40	1·20	1·40	3·30	4·70	2·30	7·30	6·02	6·26	5·50	1·99
FeO ...	...	0·90	0·37	0·45	0·45	...	...	...	0·18	0·86						0·54
MnO ...	0·26	nil	nil	Tr.	...	0·02	0·02	Tr.	Tr.	0·02	...	...	...	...	...	0·08
MgO ...	0·90	0·55	0·28	0·56	0·46	0·60	0·58	0·44	0·57	0·40	0·73	...	...	...	0·70	0·56
CaO ...	0·80	0·84	0·09	0·33	0·21	...	nil	nil	0·30	0·02	1·33	0·32	0·30	0·58	0·20	0·44
Na_2O ...	0·28	0·06	0·53	0·29	0·28	0·14	0·21	0·15	0·11	0·30	...	...	...	...	0·08	0·22
K_2O ...	2·20	1·90	1·59	1·87	1·98	2·69	2·50	2·06	2·31	2·30	...	...	...	...	2·06	2·13
H_2O+ ...	3·93	6·34	2·91	5·83	5·60	6·66	6·62	6·80	5·67	7·05	6·84	...	...	...	11·00	5·87
H_2O- ...	1·17	1·94	1·02	1·67		1·07	0·88	1·42	0·97	3·24	1·55	...	...	...		1·49
P_2O_5 ...	0·10	0·11	0·14	0·15	...	0·07	0·12	0·07	0·23	0·17	...	...	...	...	...	0·13
CO_2 ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
SO_3 ...	...	...	...	...	...	Tr.	Tr.	Tr.	...	...	...	...	...	...	Tr.	Tr.
Cl ...	...	...	...	...	....	Tr.	Tr.	Tr.	...	...	...	...	...	...	...	Tr.
BaO ...	...	...	...	...	...	<0·01	< 0 1	<0·01	...	...	...	...	...	...	...	...
SrO ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
NaCl ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Organic ...	3·74	...	...	...	...	1·09	1·14	0·08	0·88	nil.	...	...	...	...	0·40	1·22
Misc. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Tr.*b*	Tr.
	100·00	100·09	99·77	100·36	99·98	99·82	99·97	100·17	100·22	100·31	100·00	...	...	...	100·26	100·08

a. With alkalies and undetermined.

b. FeS_2.

1. "Shale".—Waterloo Brickworks. *Ann. Rep. Mines Dept. N.S.W.*, 1912, p. 195. Analysis No. 2156.
2. "Shale".—Waterloo Brickworks. *Ibid.*, 1912, p. 195. An. No. 2157.
3. "Shale".—Waterloo Brickworks. *Ibid.*, 1912, p. 195. An. No. 2158.
4. "Shale".—Waterloo Brickworks. *Ibid.*, 1912, p. 195. An. No. 2159.
5. "Shale".—Industrial Quarry, Waterloo. *Ibid.*, 1912, p. 195. An. No. 852.
6. "Clay-shale".—State Brickworks, Botany. *Ibid.*, 1915, p. 177. An. No. 1170.
7. "Shale".—State Brickworks, Botany. *Ibid.*, 1917, p. 177. An. No. 1171.
8. "Shale".—State Brickworks, Botany. *Ibid.*, 1917, p. 177. An. No. 1172.
9. "Clay-shale".—Homebush State Brickworks. Mines Dept. N.S.W. An. No. 2/1912.
10. "Clay-shale" (weathered, from overburden).—Homebush State Brickworks. Mines Dept. N.S.W. An. No. 3/1912.
11. "Shale".—Hurstville State Brick Co. Mines Dept. N.S.W. Analysis.
12. "Clay-shale".—Central Brick Pit, St. Peters. Mines Dept. N.S.W. An. No. 877/1915.
13. "Clay-shale".—Bakewells Brick Pit, St. Peters. Mines Dept. N.S.W. An. No. 878/1915.
14. "Clay-shale".—Sydney Brick Co. Pit, St. Peters. Mines Dept. N.S.W. An. No. 879/1915.
15. "Shale".—Berrima. *Ann. Rep. Mines Dept. N.S.W.*, 1924, p. 106. An. No. 3182. Analyst, W. A. Greig.
16. Average, 1–15.

TABLE 3.

Analyses of Ashfield Shale.

>100 feet above Hawkesbury Sandstone

	1	2	3	4	5	6	7	8	9	10	11	12	13
SiO_2	70·60	72·31	65·80*c*	62·79*d*	61·50*e*	61·74*f*	61·96*g*	69·92	73·10	66·10	65·73	58·10	51·03
TiO_2	...	0·65	0·90	0·75	0·70	0·64	0·60	0·84	...	...	0·74	0·65	...
Al_2O_3	13·45*a*	13·86	17·63	17·97	16·29	15·68	17·44	19·47	16·53	21·46	16·98	15·40	13·47
Fe_2O_3	5·75	2·30	2·15	3·50	7·50	7·60	5·60	1·60	0·20	0·33	4·04	4·02	8·06
FeO	0·31	0·36	0·31	0·45	0·36	0·35	0·36	0·87	0·63	0·87	0·49	2·45	...
MnO	0·02	0·04	Tr.	Tr.	Tr.	Tr.	Tr.	nil	Tr.	Tr.	0·02	...	...
MgO	0·54	0·69	0·59	0·78	0·50	0·74	0·73	0·94	0·25	0·47	0·64	2·44	1·15
CaO	0·50	0·12	0·15	0·40	0·09	0·70	0·54	0·46	0·60	0·60	0·40	3·11	0·78
Na_2O	0·79	0·59	0·89	0·58	0·48	0·38	0·43	0·15	0·38	·019	0·51	1·30	0·41
K_2O	1·14	0·97	1·28	2·11	0·52	1·38	1·21	2·91	1·49	3·11	1·48	3·24	3·16
H_2O+	6·60	5·61	5·80	6·30	7·06	6·56	6·33	5·61	5·47	6·09	6·33	5·00	0·81
H_2O-		2·44	4·22	3·78	3·84	4·30	4·79	2·60	1·70	1·15	3·36		
P_2O_5	0·08	0·04	0·08	0·03	0·06	0·05	0·02	0·04	...	...	0·05	0·17	0·31
CO_2	nil	...	...	...	...	...	...	...	...	...	...	2·63	...
SO_3	...	Tr.	Tr.	0·27	0·11	0·06	0·04	nil	...	...	0·11	0·64	...
S	...	...	...	...	...	...	...	...	...	...	...	...	7·29
BaO	...	Tr.	0·04	0·38	0·05	Tr.	Tr.	...	...	...	0·12	...	...
SrO	...	nil	Tr.	Tr.	Tr.	nil	nil	...	...	...	Tr.	...	...
NaCl	...	0·15	0·20	Tr.	0·26	0·18	0·20	...	...	...	0·21	...	...
Organic ...	0·22*b*	nil	0·35	nil	0·70	nil.	nil	1·47*h*	nil	0·13	0·5	0·80	13·11
Misc.	...	...	...	...	...	...	...	...	...	...	...	...	...
	100·00	100·13	100·36	100·10	100·02	100·30	100·25	100·00	100·35	100·50	100·21	99·95	102·90*i*

1. "Clay-shale".—1¼ m. west of Auburn. *Ann. Rep. Mines Dept. N.S.W.*, 1914, p. 216. Analysis No. 4378.
2. "Clay-shale".—Shannon's Pit, Duck Creek, Auburn. Mines Dept. N.S.W. An. No. 3936.
3. "Clay-shale".—Trenholmes Pit, Mary Street, Auburn. Mines Dept. N.S.W. An. No. 3937.
4. "Clay-shale".—Sherwood Brick and Tile Works, Auburn. Mines Dept. N.S.W. An. No. 3938.
5. "Clay-shale".—Sherwood Brick and Tile Works, Auburn. Mines Dept. N.S.W. An. No. 3939.
6. "Clay-shale".—Goodlet and Smith's Quarry, Granville. Mines Dept. N.S.W. An. No. 3940.
7. "Clay-shale".—Goodlet and Smith's Quarry, Granville. Mines Dept. N.S.W. An. No. 3941.
8. "Clay-shale".—Concord. *Ann. Rep. Mines Dept. N.S.W.*, 1912, p. 195. An. No. 2161.
9. "Micaceous shale (light coloured)".—Rouse Hill, Parramatta. *Ibid.*, 1899, p. 204. An. No. 4534.
10. "Micaceous shale (light coloured)".—Rouse Hill, Parramatta. *Ibid.*, 1899, p. 204. An. No. 4535.
11. Average, 1–10.
12. Average shale.—*U.S. Geol. Surv. Bull.* 770, 1924, p. 34.
13. Black shale.—Dry Gap, U.S.A. *U.S. Geol. Surv. Bull.*, 770, 1924, p. 552. Includes 3·32 hydrocarbons. Analyst, L. G. Eakins.

a Including any TiO_2 present.
b Organic plus undetermined.
c Free SiO_2 = 33·60; Combined SiO_2 = 32·20 } 65·80.
d Free SiO_2 = 31·45; Combined SiO_2 = 31·34 } 62·79.
e Free SiO_2 = 34·90; Combined SiO_2 = 26·60 } 61·50.
f Free SiO_2 = 33·94; Combined SiO_2 = 27·80 } 61·74.
g Free SiO_2 = 33·08; Combined SiO_3 = 28·88 } 61·96.
h Organic plus undetermined.
i Less O = S; total becomes 100·17.

Analyses of shales from the Ashfield Shale have been recorded and for convenience have been divided into analyses of shale less than 100 feet above (Table 2) and more than 100 feet above (Table 3) the Hawkesbury Sandstone.

The average analysis for each table is very similar and appears to be a normal shale by comparison with the analysis (Table 3, No. 12) of the average shale of Clarke. Organic matter is almost always present but not to the extent of the analysis (Table 3, No. 13) of a black shale from Dry Gap, U.S.A. The black colour so typical of the Ashfield Shale is partly due to this organic matter but the rather high total iron content, together with some FeS_2, would account for the dark colour. The main point of difference from the average shale analysis is the almost universal preponderance of MgO over CaO—a state of affairs more in keeping with Pettijohn's (1949, p. 273) views for the normal shale. In general the CaO content is low and no analysis would fall under the category of a calcareous shale. A cone-in-cone calcareous shale does exist as well as calcite fillings of sub-vertical joints and cavities, so it appears that some horizons, at least, are more calcareous than the analyses would suggest.

Preliminary work has indicated that two horizons, characterized by a particularly unusual lithologic type, may be recognized. Future work could profitably be directed to a more detailed examination of their vertical and horizontal stratigraphic extent for possible use as marker horizons.

The Cone-in-cone Shale.—A band of calcareous cone-in-cone shale occurs in the floor of the Ashfield Brickworks Quarry, about 50 feet below the ground surface and approximately 100 feet above the top of the Hawkesbury Sandstone. The thickness is rather irregular but never exceeds 6 inches. The cones are of the usual type with the apices vertical to the bedding.

TABLE. 4

Analyses of Calcareous Members of the Ashfield Shale.

Type.	Locality.	Reference.	Soluble Residue.	Insoluble Residue.
Calcareous cone-in-cone shale.	Picton district	Sach (1892)	Per cent. 21·2	Per cent. $CaCO_3$: 67·54 Fe_2O_3 : 4·14 $MgCO_3$: 0·70 H_2O : 3·1
Calcareous clay-shale ...	5 miles from Picton towards The Oaks.	*Ann. Rep. Dept. Mines, N.S.W.*, 1906, p. 182.	78·18	$CaCO_3$: 5·46 Fe_2O_3 + Al_2O_3 : 7·0 MgO + Undetermined : 2·16 H_2O : 7·20

A similar occurrence was described by Sach (1892) from the "upper course of the Picton Creek". The locality is not well defined but it is most probably comparable in stratigraphic position with the Ashfield locality. An insoluble residue test showed the residue to be mostly fine sand particles mixed with clay matter. Table 4 gives a partial analysis of the soluble portion.

The Mottled Sideritic Mudstone.—Between 0 and 50 feet above the base of the Ashfield Shale there is a zone formed by several bands of a hard, black sideritic mudstone with a peculiar light-coloured mottling. The cause of the mottling is not apparent, but it may be due to a concentration of clay matter about a number of centres. Several bands, from 3 to 6 inches thick, make up the zone and are interbedded with the normal black shale of the Ashfield Shale.

The zone has been recorded from a wide area; specimens have been collected from Mortdale Brick Quarry (Sydney 083027), road cutting on Mount Hunter-High

Range road (Camden 604888), railway cutting on Picton-Thirlmere loop (Camden 595790), shallow quarry on Douglas Park-Cordeaux Dam road (Camden approx. 723728), road cutting on Werombi road (Camden 612993) and from along the Burragorang Valley-The Oaks road.

It seems likely that the zone will prove very useful as a marker horizon for further detailed stratigraphic work on the Ashfield Shale.

Thickness.—The average thickness of the Ashfield Shale is 200 feet. A minimum of 150 feet and a maximum of 210 feet would cover all known measurements.

Palaeontology.—In common with black shale associations in world-wide occurrences, fossils are comparatively rare in the sequence. Only a few *Phyllotheca* fragments have been collected during this work but previous records have been made of other forms of plants and animals. Some of the old identifications and names may be viewed with some suspicion but, for completeness, are included in this list.

Flora.

Etheridge (1889): *Cycadopteris scolopendrina.*

Tillyard (1916): *Thinnfeldia, Sphenopteris, Cladophlebis, Macrotaeniopteris, Oleandridium, Taeniopteris, Podozamites, Baiera.*

Fauna.

Lamellibranchia: An assemblage of rather small freshwater lamellibranchs was described by Etheridge (1888) from the basal beds of the Ashfield Shale and the passage beds with the Hawkesbury Sandstone at Surry Hills, Waterloo, and the railway cutting at the north end of the Gibraltar Tunnel (Mittagong 417435). *Unio? wianamattensis, Unio dunstani* and *Unionella bowralensis* were described and named. After an inspection of the type material, Mr. D. F. McMichael of the Australian Museum has reported: "The fossil lamellibranchs were described as belonging to the genera *Unio* and *Unionella,* the latter having doubtful affinities with the family Unionidae. Present-day classification of the freshwater mussels of the world allows four distinct families with numerous sub-families. The genus *Unio* is confined to recent specimens from England and Europe. The true generic relations of the group are obscure but most of the species of *Unio* described by Etheridge seem to definitely belong to the freshwater mussels. The form *Unionella bowralensis* seems to be more closely related to *Unio wianamattensis* while the *Unio dunstani* has rather different affinities and probably represents a distinct genus."

Isopoda: Chilton (1917) described a freshwater form *Phreatoicus wianamattensis* from the basal beds of the Ashfield Shale at Newtown.

Insecta: Tillyard (1916) recorded an insect assemblage from the basal beds at St. Peters: *Notoblattites subcostalis, Mesotitan giganteus, Elaterites wianamattensis, Metrorhynchites sydneiensis, Etheridgea petricia, Mesorhynchophora dunstani.*

Amphibia: A well preserved specimen of *Cyclotosaurus* was found at St. Peters and is the only complete stereospondylous labyrinthodont known. *Bothriceps* and *Mastodonsaurus* have also been recorded.

Fish: Smith-Woodward (1908) described a fish fauna from the basal beds of the Ashfield Shale, less than 100 feet above the Hawkesbury Sandstone at St. Peters. Two distinct faunas occurring in two different host rock-types were described. A. "From dark indurated shale" (probably one of the sideritic mudstone bands): *Pleuracanthus parvidens, Sagenodus laticeps, Palaeoniscus crassus, Elonichthys armatus, Elonichthys semilineatus, Myriolepis pectinata, Elpisopholis dunstani, Platysomus* sp., *Acentrophorus* sp. B. "From soft grey shale or mudstone" (the normal black shale type): *Palaeoniscus antipodeus, Semionotus formosus, Cleithrolepis granulatus, Pholidophorus australis.*

Age.—It is an important observation that the fossils listed are confined to the basal 100 feet of the Ashfield Shale while the other seven formations of the approximately 800 feet thick Wianamatta Group have no recorded fossils. Attempts to fix the age of the Group on the recorded fossils are based on insufficient evidence and only the age of the fossiliferous basal beds of the Ashfield Shale can be derived. From this, David's (1950) statement "the fossil evidence shows that these (the Wianamatta Series) are Upper . . . Triassic" cannot be applied to the whole of the Wianamatta Group. The evidence would suggest, however, that at least the basal parts of the Ashfield Shale are probably Upper Triassic.

Relation to Underlying Formation.—The Ashfield Shale lies directly upon the Hawkesbury Sandstone, the junction usually being described as showing evidence of contemporaneous erosion. The general relation seems rather to be transitional with the typical massive orthoquartzites of the Hawkesbury Sandstone giving way, through a series of passage beds, to the black shales of the Ashfield Shale.

The passage beds, varying in thickness between 0 and 20 feet, with an extreme thickness of approximately 50 feet as in the Gib Tunnel cutting (Mittagong 417435), consists of alternating black shale and sandstone bands and lenses of varying thickness. The shales are black and are comparable with the normal type Ashfield Shale and also very similar to the bands and lenses of black shale occurring lower down in the Hawkesbury Sandstone sequence itself. The sandstones of the passage beds are generally reminiscent of the orthoquartzites of the Hawkesbury Sandstone although finer grained and almost always calcareous. A similar thickening of the passage beds is to be found in other areas of the Mittagong sheet.

The boundary between the Wianamatta Group and the Hawkesbury Sandstone, where passage beds occur, has been fixed at the top of the uppermost sandstone band in the transitional zone. The passage beds are considered with the Hawkesbury Sandstone. The boundary is not placed arbitrarily, but has a genetic significance in as much as: (1) the Ashfield Shale so defined is a lithologically homogeneous shale formation, and (2) the black shale of the passage beds does allow comparison with the shale lenses in the Hawkesbury Sandstone while no sandstones of that type are found in the true sequence of the Wianamatta Group.

Because of the lithologic similarity of the normal black Ashfield Shale and shale lenses in the Hawkesbury Sandstone, some of the isolated thin outcrops of shale referred to in the maps as Ashfield Shale may actually be shale lenses within the Hawkesbury Sandstone. Differential thermal analysis of the shales (Ferguson and Hosking, 1953) has indicated a means of separating Ashfield Shale and shale from the Hawkesbury Sandstone. Preliminary work suggests that shale outcrops around French's Forest and Heathcote (shown as Ashfield Shale?) are rather referable to the shale in the Hawkesbury Sandstone.

(ii) *Minchinbury Sandstone.*

Name.—The Minchinbury Sandstone derives its name from the district and trig. station Minchinbury (Liverpool 827244) about 4 miles east of St. Marys along the Great Western Highway. Minchinbury is also the name of a vineyard in the area owing its existence to the calcareous soil provided by the rock type of the formation.

Type Area and Section.—Willan (1923) recognized the formation and put it in his Middle Stage. David (1950) referred it to his Middle Stage and compared it incorrectly with the sandstones of the Razorback Range.

The type area, with the best natural outcrops, is in the Minchinbury district described above. The best sections are figured in the logging of the Water Board bores (Figures 9, 10). These are the type sections, the cores being quite well preserved at the Water Board's depot at Potts Hill.

Other Localities.—The outcrop of the Minchinbury Sandstone is generally very weak and is only apparent when excavations and bores have revealed it in section. This fact, together with the thick soil cover, makes accurate mapping of the outcrop very difficult between areas of known occurrence. The comparatively minor thickness has proved difficult to show on the inch-to-mile scale of the maps and the width of outcrop is, in general, rather arbitrary.

Sections are shown in road cuttings in several districts: Grose Vale-Kurrajong (Windsor 643516 and 649532); Kellyville (Windsor 974329); Rogans Hill (Broken Bay 017324); Epping (Sydney 074261); Bankstown Brick Quarry (Sydney 024086); Pendle Hill (Liverpool 943230); Bonnyrigg (Liverpool 867137); Menangle (Camden 714842); Brownlow Hill (Camden 644981); Gingenbullen (Moss Vale 309344); and other localities.

Lithology.—The sedimentary petrology of the sandstone formations is discussed in more detail below (p. 194). The discussion here is limited to a description of the main lithologic characteristics.

The Minchinbury Sandstone, in common with the other sandstones, is more closely allied to the graywacke types; however, the term "sandstone" is retained in the formational name as it best describes the field occurrence of the rock. In other outcrops it resembles a grey, compact calcareous marlstone, probably a transitional type to the associated shales. The sandstone is typically calcareous and secondary calcite veins often occur. The section is normally quite massive but some sections are split by dark shale lenses. Fragments of the shale (often calcareous), angular pieces of chert, ironstone and sideritic nodules are often seen in the sandstone. Current bedding, usually from a northerly direction, and ripple marks also occur.

The fresh sandstone is characteristically blue-grey but rapidly weathers to a buff colour. The exposed sections in road cuttings have a characteristic tendency to spheroidal weathering and it spalls easily.

Thickness.—The usual thickness of the massive section varies between 10 and 20 feet. A maximum thickness of 35 feet was measured in Bore 15N of the City Tunnel Series (Figure 9) in which the massive sandstone was very much broken by black shale bands.

Palaeontology.—Plant fragments, apparently of *Phyllotheca,* are abundant along bedding planes in the massive sandstone as well as the associated shale lenses. No specimens have been recorded from the formation.

An important microfossil assemblage of algae (*Globochaete alpina, Eothrix alpina*), foraminifera (cf. *Trochammina, Spiroplectammina, Fibrosphaerae*) and ostracoda has been recorded (Lovering, 1953).

Age.—Chapman (1909), on the evidence of an assemblage of ostracods and foraminifera described by him, considered that there was an indication of "a curious intermingling of Rhaetic and Lower Jurassic types, with others more properly referable to the Upper Palaeozoic of Europe". In view of the uncertainty of these identifications (Lovering, 1953), however, little reliance can be placed on these microfossils alone as an indication of a definite Jurassic age. The problem has other features which have been discussed above (p. 171).

Relation to Underlying Formation.—The Ashfield Shale is related to the Minchinbury Sandstone by means of a marked change in lithology. The boundary is quite definite and is defined at the appearance of the first sandstone in the sequence.

(iii) *Bringelly Shale.*

Name.—The outcrop of the shale formation defined as the Bringelly Shale has its greatest geographic extent in the area around Bringelly (Liverpool 730070). It is from this town that the geographic name is taken.

Type Area and Section.—The Bringelly Shale has its type area around the Bringelly district but even here the poor outcrop and low relief of the area preclude the occurrence of any complete natural section. The sequence logged in the Water Board's City Tunnel exploratory bores (Figures 9 and 10), although taken from poorly preserved cores, is used as the type section.

Other Localities.—This formation has extensive outcrops in the Sydney (around the western suburbs), Liverpool and Camden Sheets.

Small, isolated outcrops also occur capping Box Hill (Windsor 643516), Rogans Hill (Broken Bay 017324) and Gingenbullen (Moss Vale 309344).

Lithology and Petrology.—The predominant lithologic type is shale. When unweathered the shale is dark and resembles the black shale of the Ashfield Shale although it lacks the sideritic mudstone bands characteristic of that formation. Usually, and more particularly when weathered, the shale is a typical olive-green colour. Impure coal bands and lenses and iron oxide concretions have been recorded in the shales.

The Bringelly Shale differs from the Ashfield Shale in having a subsidiary sandstone lithology. The sequence has many sandstone bands and lenses varying from 1 inch to 5 feet in thickness, with a tendency for the thicker bands to be concentrated at the top. The horizontal extent of the bands is very limited and most thin out very rapidly. As a type, these sandstones are identical with those of the other more massive formations and related to the graywacke-types (see p. 188).

TABLE

Analyses of Bringelly Shale.

	1	2	3	4
SiO_2	74·30	65·97	70·13	77·8
TiO_2	0·44	0·70	0·57	0·6
Al_2O_3	13·65	20·59	17·12	9·5
Fe_2O_3	0·60	Tr.	0·60	0 9
FeO	1·34	1·08	1·21	2·6
MnO	0·10	...	0·10	0·2
MgO	0·64	0·55	0·59	1·6
CaO	0·46	0·11	0·28	1·2
Na_2O	1·00	0·88	0·94	2·0
K_2O	1·48	2·13	1·80	1·5
H_2O+	3·68	5·13	4·40	1·6
H_2O-	1·32	1·60	1·46	0·1
P_2O_5	0·05	0·16	0·11	0·2
CO_2	...	...	...	0·5
S	...	...	...	0·1
Organic	0·94*a*	1·47	1·20	0·2
	100·00	100·37	100·18	100·4

a. Organic plus undetermined (trace of soluble chlorides detected).

1. "Clay-shale".—Lion Tile Quarry, Liverpool Road, Enfield. Mines Dept. N.S.W. Analysis No. 1679/1912.
2. "Clay-shale".—Liverpool Road, South Strathfield. *Ann. Rep. Mines Dept. N.S.W.*, 1912, p. 195. An. No 2064.
3. Average 1 and 2.
4. Average of three subgraywackes. Pettijohn (1949), p. 256.

Table 5 gives analyses of two samples of Bringelly Shale. A comparison with the analyses of Ashfield Shale (Tables 2 and 3) shows some similarity save in one important regard—the predominance of ferrous over ferric iron. In this respect it suggests comparison with the average analysis of three subgraywackes (Pettijohn, 1949) given in the same Table. Although the Bringelly Shale analyses do show a rather smaller Na_2O than K_2O content, the similarity is sufficient to suggest that the shales are of comparable composition with the subgraywackes with which they are associated and, following from this, are actually the shale equivalents of the graywacke-subgraywacke sandstones.

The shales are quarried in several western suburbs of Sydney for brick and general ceramic manufacture.

Thickness.—The formation has a rather constant thickness around 200 feet.

Palaeontology.—No fossils have yet been recorded from this formation. Plant remains, probably of *Phyllotheca,* are very abundant in the shales and are also found in the sandstone bands.

Relation to Underlying Formation.—The rather massive Minchinbury Sandsone passes quite abruptly into the shales of the Bringelly Shale. Some evidence of contemporaneous erosion can be found, though very much localized at the contact.

The Camden Sub-group.

(i) *Potts Hill Sandstone.*

Name.—The formation defined as the Potts Hill Sandstone takes its name from a low ridge of Potts Hill (Sydney 030115) about 1 mile north of Bankstown, a suburb to the west of Sydney. The ridge owes its existence to the resistant outcrop of the sandstones.

Type Area and Section.—The type area and section is that of the Water Board quarry at Potts Hill (Sydney 028121). The quarry face varies between 20 and 25 feet but is an excellent section to illustrate the characteristic lateral variation from at least 25 feet of massive sandstone to sandstone very much broken by silty dark shale bands and lenses.

Other Localities.—The outcrop of the Potts Hill Sandstone forms the lowest of the three bench levels which mark the outcrop of the three major sandstone formations of the Upper Division. It is well shown in cuttings along the Hume Highway and other roads over the Razorback Range.

There are a number of other outcrops in the Liverpool and Camden Sheets. Good sections are often available in small quarries opened up in the sandstone at a number of localities in these sheets: Hoxton Park (Liverpool 833091) and Cecil Hills; Bringelly district (Liverpool 723033); Western side of Badgelly Trig. (Camden 783946); near Kelly Hill (Camden 780927); western side of Mount Annan (Camden 760903); Sugarloaf Hill (Camden 775875).

Lithology.—In the general case, the Potts Hill Sandstone is a massive formation of the graywacke-type sandstone characteristic of the Wianamatta Group. The type at Potts Hill is rather unusual in as much as it is considerably richer in quartz than the normal sandstone and is rather a feldspathic sandstone (see p. 196). All types are often calcareous and subvertical joints filled with secondary calcite are common.

Black and greenish shale lenses show in varying abundance throughout the section. Iron oxide and sideritic nodules, current-bedded layers (generally from a northerly direction) and spheroidal weathering (in the more massive outcrops) are commonly shown.

Thickness.—A maximum thickness of 40 feet has been observed on the Razorback Range section but 30 feet is an average measurement.

Palaeontology.—McCoy (1847) described a number of plants (*Gleichenites odontopteroides, Odontopteris microphylla, Pecopteris ? tenuifolia, Phyllotheca hookeri*) from "the fine sandstone at Clarkes Hill, near Cobbittee". The locality is rather doubtful and cannot be traced, but it seems likely that it refers to an outcrop of the Potts Hill Sandstone, probably one of the outcrops capping two hills to the east of Cobbitty and about 2 miles north of Narellan.

Relation to Underlying Formation.—The Bringelly Shale passes into the Potts Hill Sandstone through a small transitional zone of alternating sandstone and shale bands. The passage from the dominant shale formation to the massive sandstone is complete in less than 10 inches.

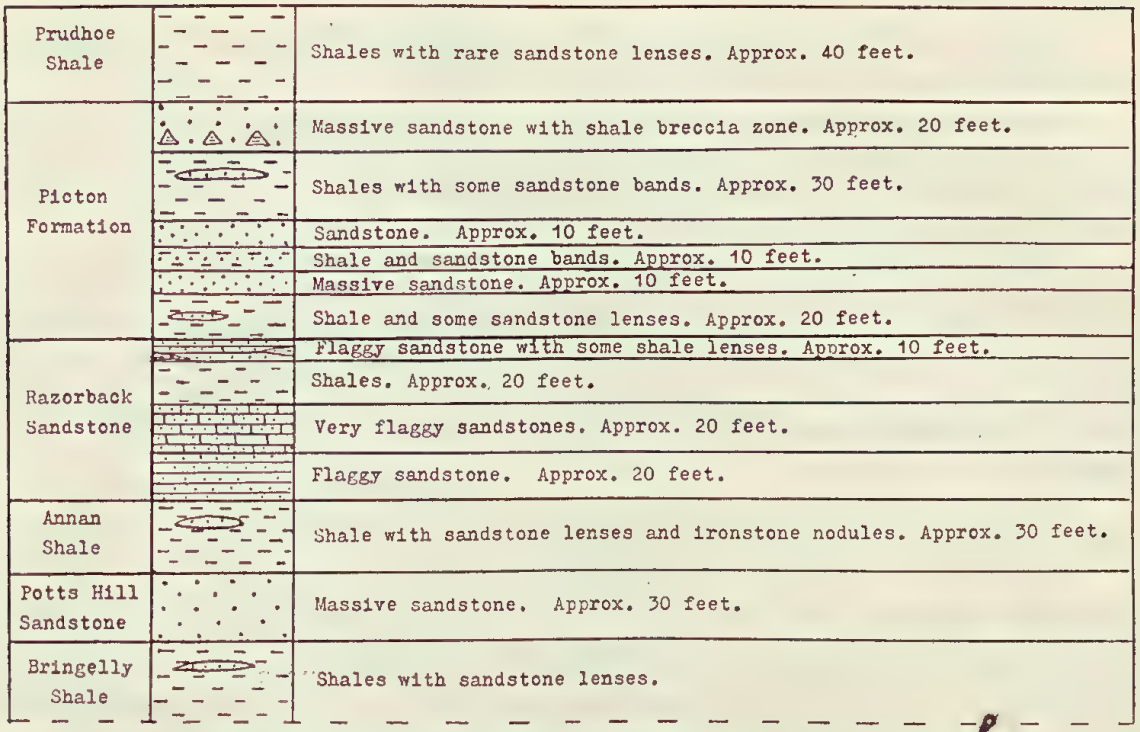
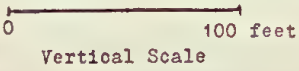

Prudhoe Shale
Shales with rare sandstone lenses. Approx. 40 feet.
Picton Formation
Massive sandstone with shale breccia zone. Approx. 20 feet.
Shales with some sandstone bands. Approx. 30 feet.
Sandstone. Approx. 10 feet.
Shale and sandstone bands. Approx. 10 feet.
Massive sandstone. Approx. 10 feet.
Shale and some sandstone lenses. Approx. 20 feet.
Razorback Sandstone
Flaggy sandstone with some shale lenses. Approx. 10 feet.
Shales. Approx. 20 feet.
Very flaggy sandstones. Approx. 20 feet.
Flaggy sandstone. Approx. 20 feet.
Annan Shale
Shale with sandstone lenses and ironstone nodules. Approx. 30 feet.
Potts Hill Sandstone
Massive sandstone. Approx. 30 feet.
Bringelly Shale
Shales with sandstone lenses.

Fig.3 Section along the Hume Highway on the South side of Razorback.



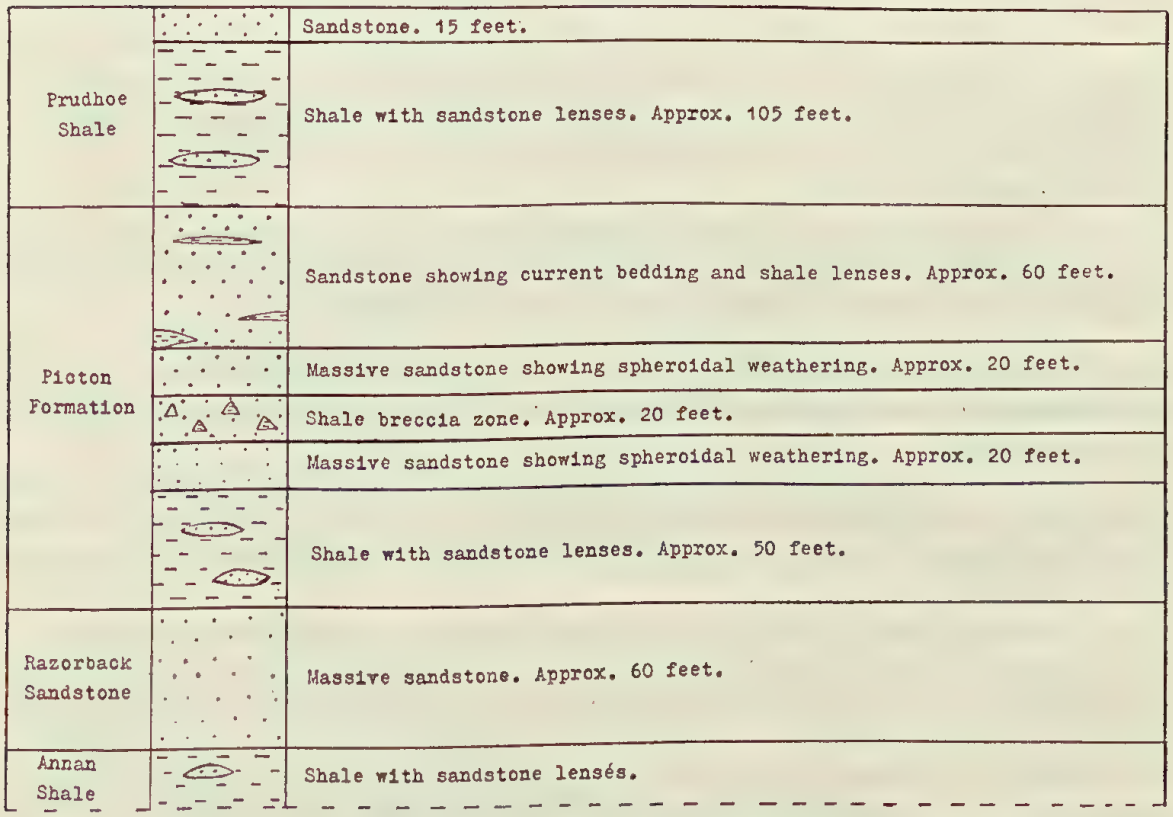
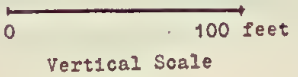

Prudhoe Shale
Sandstone. 15 feet.
Shale with sandstone lenses. Approx. 105 feet.
Picton Formation
Sandstone showing current bedding and shale lenses. Approx. 60 feet.
Massive sandstone showing spheroidal weathering. Approx. 20 feet.
Shale breccia zone. Approx. 20 feet.
Massive sandstone showing spheroidal weathering. Approx. 20 feet.
Shale with sandstone lenses. Approx. 50 feet.
Razorback Sandstone
Massive sandstone. Approx. 60 feet.
Annan Shale
Shale with sandstone lenses.

Fig.4 Section along the North side of the Old Razorback Road.



(ii) *Annan Shale.*

Name.—The Annan Shale takes its geographical name from Mount Annan, parish Narellan, county Cumberland. (Camden 760903).

Type Area and Locality.—The type area is the Razorback Range and the type section is exposed along the Hume Highway on the south side of the Razorback Range. This section, of some 30 feet of dark and green shales with lenses and bands of graywacke-type sandstone, is shown in Figure 3.

Other Localities.—Other outcrops are to be found in the Liverpool Sheet, where the Annan Shale outcrops in the high country above the Cecil Hills Tunnel and again in the area to the south-west of Bringelly, and in the Camden Sheet where, besides the main outcrop in the Razorback Range, others less prominent occur as follows: north of Narellan (729975); Badgelly Trig. (783946); near Kenny Hill (780927); Mount Annan (760903); north-west of Mount Annan (745920); and Sugarloaf Hill (775875).

Lithology.—The normal section is of grey-green shales, rather dark when unweathered, and commonly with iron-oxide nodules and concretions.

Thickness.—The type section is 30 feet, but the formation shows a tendency to variable thickness. The northern side of the Hume Highway climb over Razorback shows another section in which the Annan Shale, still with the same lithology, reaches a maximum of about 120 feet though accurate measurements are impossible due to a cover of land-slip and scree material. This is a maximum measurement and an average thickness of 40 feet has been derived from a consideration of all sections.

Palaeontology.—No fossils have been recorded from this formation but *Phyllotheca*-like fragments are common. A zone in which plant fragments are extremely abundant occurs along the northern climb of the Hume Highway over Razorback.

Relation to Underlying Formation.—The Potts Hill Sandstone passes rather rapidly into the Annan Shale through a distinct lithologic break. Passage beds, less than 10 inches thick, of alternating shales and sandstone bands mark the junction—the shale bands becoming more prominent towards the Annan Shale.

(iii) *Razorback Sandstone.*

Name.—The Razorback Range (parish Picton, county Camden) is a prominent geographic feature crossed by the Hume Highway about 7 miles south of Camden. This formation takes its geographic name from this feature.

Type Area and Section.—The type area is the Razorback Range and the type section is shown in cuttings along the northern climb of the Hume Highway over the Razorback Range (Camden 691825) where 60 feet of massive graywacke-type sandstone is exposed.

Other Localities.—The outcrop of the Razorback Sandstone is generally marked by the presence of the distinct second physiographic bench-level. This level has been recognized in the type area at Razorback but also in the outcrops in both the Liverpool and Camden Sheets.

Liverpool Sheet: Isolated outcrops occur around Cecil Hills and Bringelly.

Camden Sheet: Scattered outcrops cap various geographic features in the area: north of Narellan (729975); Badgelly Trig. 783946); near Kenny Hill (780927); Mount Annan (760903); north of Mount Annan (745920); Sugarloaf Hill (775875).

Lithology.—In general the formation follows the lithologic pattern of the type section—60 feet of massive graywacke-type sandstone with some very thin (less than 12 inches) and horizontally restricted dark shale lenses. Current bedding (with a southerly dip), iron-oxide concretions and calcite veins are common.

Another section (Figure 3) exposed in the cuttings along the south side climb of the Hume Highway over Razorback shows the shale bands becoming much more prominent although still subsidiary to the essentially sandstone lithology.

Thickness.—The formation has a rather consistent thickness of between 60 and 70 feet.

Palaeontology.—Plant fragments are abundant in both the sandstone and associated shales but no recorded occurrences are available.

Relation to Underlying Formation.—The Annan Shale gives way to the Razorback Sandstone through a rather definite lithologic break. Generally there is a zone of several thin sandstone bands alternating with shale bands before the rather massive sandstone of the Razorback Sandstone becomes dominant.

(iv) *Picton Formation.*

Name.—The town of Picton, parish Picton, county Camden (Camden 608795), by reason of its close geographic association with the outcrop of the formation has been chosen as the geographic name.

Type Area and Section.—The type area is the Razorback Range and the type section is exposed along the Hume Highway on the south side of Razorback Range (approx. Camden 664812) and shown in Figure 3.

Other Localities.—The outcrop of the formation is characterized by the final (third) physiographic bench-level first recognized in the type area. The level may be traced to another outcrop in the Liverpool Sheet where the Picton Formation caps a hill to the south-west of Bringelly (Liverpool 694017).

Lithology.—This formation differs from the other formations defined in the Wianamatta Group in that its lithology cannot be conveniently described by a single lithologic term and, in accordance with the Australian Code of Stratigraphic Nomenclature (Raggatt, 1950), the designation "Picton Formation" is appropriate.

The variability in the sequence is apparent from Figures 3 and 4 in which two sections of the formation, including the type section, are figured. Shales and graywacke-type sandstones alternate and intercalate in a rather haphazard way although it already seems apparent that a further division into constituent members will be possible. The sequence does show sufficient regularity to enable the formation to be defined: (*a*) the lower part of the section is predominantly shale, differentiating the Picton Formation from the underlying massive Razorback Sandstone, and (*b*) the upper portion is invariably a massive sandstone between 20 and 60 feet thick. The resistant outcrop of this member is responsible for the characteristic third bench-level.

The section in the vicinity of Peach Tree Bend (Camden 663832) on the north climb of the Old Razorback Road (see Figure 4) is complicated by local warping and soil cover but an important shale breccia zone, about 15 feet thick, is evident. Dark shale fragments, usually sub-angular, are very closely packed in a matrix of the normal greenish graywacke-type sandstone. This shale breccia zone is rather similar to others described from the Hawkesbury Sandstone (Osborne, 1948) and may, on more intensive mapping, become an important marker horizon. Preliminary work suggests that this may be the case.

The massive sandstone sections commonly show local current-bedding layers with dips generally to the south, while any section that has been exposed for some time exhibits a type of spheroidal weathering. In other zones the sandstones become rather flaggy and shale lenses creep in the section.

The shale zones, themselves associated with minor sandstone lenses, are dark when fresh but rapidly change to green-grey on exposure.

Thickness.—The type section is about 100 feet thick but this measurement does vary considerably in other sections. The Peach Tree Bend section, though difficult to

record accurately, is around 160 feet while other sections have thicknesses less than 100 feet.

Palaeontology.—Poorly preserved plant fragments are common through the sequence.

Relation to Underlying Formation.—In the definition of the Picton Formation it was pointed out that the basal beds were invariably shale types. These shales lie with a rather sharp lithologic break on the massive sandstone of the Razorback Sandstone; little in the nature of a transitional zone is apparent.

(v) *Prudhoe Shale.*

Name.—Mount Prudhoe is the name of the highest point of the Razorback Range, being the hill marked by the trig. station 1071 feet in portion 110, parish Picton, county Camden (Camden 663829). Prudhoe is taken as the geographical name for the Prudhoe Shale, the last existing formation of the Wianamatta Group.

Type Area and Section.—The type area is the Razorback Range but the type section is difficult to define. The thickest section (under Mt. Prudhoe) has only the lower beds exposed in the Old Razorback Road cuttings while the upper part is covered by soil. A composite section has been drawn from the observations made and is shown in Figure 4.

Other Localities.—The Prudhoe Shale is almost confined to the higher parts of the Razorback Range and even in this area the greater portion of the outcrop is restricted to thin shale beds capping the upper bench-level marking the top of the Picton Formation. One very isolated occurrence, too small to be apparent on the Liverpool Sheet, forms a thin capping of the Picton Formation to the south-west of Bringelly (Liverpool 694017).

Lithology.—The exposed beds of the section are predominantly of the usual green-grey shale with some associated graywacke-type sandstone bands and lenses. Mt. Prudhoe itself appears to be capped by a rather massive sandstone band, probably 20 feet thick.

Thickness.—With no upper limit to the formation, only a measurement of the thickest section (120 feet under Mt. Prudhoe) can be given.

Palaeontology.—*Phyllotheca*-like plant fragments are common in the section.

Relation to Underlying Formation.—The shales of the Prudhoe Shale lie conformably on the upper massive sandstones of the Picton Formation.

Sedimentary Petrology and Petrography of the Sandstone Formations.

The earliest writers on the Wianamatta Group realized the essential difference between the sandstones of the Group and those of the Hawkesbury Sandstone. The Hawkesbury types were always referred to as white, coarse-grained and porous with an abundance of glistening quartz grains. On the other hand the rather unusual Wianamatta types are green to buff coloured, fine-grained and compact with a dull lustre; they were usually described as calcareous or tuffaceous sandstones.

It was an important step to realize this inherent distinction, the genetic significance of which has only just become apparent.

The typical rock-type of the Hawkesbury Sandstone is a medium to coarse grained quartz-rich sandstone—the characteristic "orthoquartzite" of Pettijohn (1949) and the "pure quartz sandstone" of Krumbein and Sloss (1951). Some physical characteristics shown by the Hawkesbury Sandstone, and typical of the orthoquartzites are: (*a*) abundance of well sorted and rounded quartz grains with rare feldspar set in a matrix of clay, iron oxide and/or calcareous material; (*b*) stable types (tourmaline, zircon, rutile, ilmenite, etc.) predominant in the heavy mineral assemblages (Whitworth 1931); (*c*) consistency of the lithologic type; (*d*) abundance of current bedding; (*e*) rarity of fossils.

TABLE 6.

Analyses of Hawkesbury Sandstone.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2 ...	78·75*a*	82·05*d*	88·85*e*	86·75*f*	84·75*g*	91·44	90·52	81·98	85·19	74·28	87·50	79·28	79·12	79·66	83·58	92·3
TiO_2 ...	0·51	0·35	0·66	0·69	0·36	0·52	0·30	0·05	0·68	0·55	0·22	0·52	0·75	0·45	0·47	0·0
Al_2O_3 ...	10·93	9·20	6·01	6·12	8·16	4·41	4·95	9·90	6·16	11·59	7·41	7·96	8·44	9·43	7·9	1·4
Fe_2O_3 ...	0·10	0·50	0·10	0·30	0·41	0·50	0·35	0·30	0·50	0·40	0·60	1·40	0·70	0·10	0·45	0·2
FeO ...	2·48	1·92	1·37	1·92	1·56	0·18	0·18	2·07	1·71	2·79	0·09	2·88	3·42	3·00	1·83	0·3
MnO ...	0·08	0·05	0·04	0·06	0·04	nil	<0·01	...	Tr.	Tr.	Tr.	0·02	0·06	...	0·05	...
MgO ...	0·52	0·39	0·25	0·36	0·36	0·18	0·17	0·11	0·36	0·81	0·10	0·41	0·59	0·56	0·37	0·1
CaO ...	0·16	0·22	0·08	0·20	0·18	0·34	nil	0·15	0·40	1·14	nil.	0·32	0·14	0·64	0·28	3·0
Na_2O ...	0·21	0·16	0·01	0·15	0·06	0·04	0·19	0·18	0·15	0·36	0·31	0·62	0·66	0·23	0·24	0·1
K_2O ...	1·58	1·50	0·81	1·14	1·50	0·60	1·11	1·45	1·09	1·75	0·36	2·39	2·22	2·16	1·4	0·1
H_2O+ ...	2·50	1·80	1·05	0·98	1·41	1·57	2·10	8·56	1·64	2·94	2·96	2·46	1·74	1·52	1·86	0·2
H_2O- ...	0·94	0·68	0·33	0·40	0·49	0·25	0·24		0·36	0·80	0·24			0·60	0·48	
P_2O_5 ...	*b*	*b*	*b*	*b*	*b*	0·01	0·08	...	Tr.	...	0·05	Tr.	Tr.	...	0·05	...
CO_2 ...	1·61	1·34	0·84	1·29	1·16	...	...	1·14	1·07	3·03	0·04*h*	1·97	2·34	1·94	1·48	2·30
SO_3 ...	Tr.	Tr.	Tr.	Tr	Tr.	nil	nil.	nil	Tr.	0·06	0·03	...	...	...	0·05	...
Cl ...	Tr.	Tr.	Tr.	Tr.	Tr.	nil	Tr.	Tr.	Tr.	Tr.	0·02	Tr.	Tr.	...	0·02	...
Organic ...	Tr.	Tr.	Tr.	Tr.	Tr.	...	Tr.	...	...	...	...	...	...	...	Tr.	...
Misc. ...	*c*	*c*	*c*	*c*	*c*	...	...	...	...	...	...	...	...	...	...	...
	100·37	100·16	100·40	100·36	100·44	100·04	100·19	99·89	100·31	100·50	99·93	100·23	100·18	100·29	100·23	100·0

1. Sandstone.—Green's Quarry, Annandale. *Ann. Rep. Mines Dept. N.S.W.*, 1902.
2. Sandstone.—Saunders' Quarry, Pyrmont. *Ibid.*, 1902, p. 122.
3. Sandstone.—Purgatory Quarry, Pyrmont. *Ibid.*, 1902, p. 122.
4. Sandstone.—Ryan's Quarry, Waverley. *Ibid.*, 1902, p. 122.
5. Sandstone.—Phippard's Quarry, Waverley. *Ibid.*, 1902, p. 122.
6. Iron-stained sandstone.—Botany Brickworks. *Ibid.*, 1915, p. 197. An. No. 2138.
7. Kaolinized sandstone.—Botany Brickworks. *Ibid.*, 1915, p. 197. An. No. 2139.
8. "Sydney sandstone".—Undercliffe Quarry, Tempe. *Ibid.*, 1905, p. 165. Analyst, H. P. White. An. No. 4607.
9. Sandstone.—Guile Quarry, Botany. *Ibid.*, 1906, p. 182. Analyst, W. A. Greig. An. No. 1225.
10. Sandstone.—Cataract River. *Ibid.*, 1906, p. 182. Analyst, W. A. Greig. An. No. 2753.
11. Sandstone.—7 miles east of Mt. Werong. *Ibid.*, 1914, p. 217. Analyst, H. P. White. An. No. 3739.
12. Sandstone.—Core from Diamond Drill Bore, North Bondi Quarry. *Ibid.*, 1922, p. 103. An. No. 96.
13. Sandstone.—Core from Diamond Drill Bore, North Bondi Quarry. *Ibid.*, 1922, p. 103. An. No. 97.
14. Sandstone.—Gosford Freestone Quarry. *Ibid.*, 1926, p. 104. Analyst, W. A. Greig. An. No. 3380.
15. Average, 1–16.
16. Average of 7 "orthoquartzite type" sandstones. Pettijohn, 1949, p. 241.

a Free SiO_2 = 66·35; Combined SiO_2 = 12·40 } 78·75.
b Included in Al_2O_3.
c Analyses 1–5 contained a fair quantity of $FeCO_3$.
d Free SiO_2 = 72·70; Combined SiO_2 = 9·35 } 82·05.
e Free SiO_2 = 83·55; Combined SiO_2 = 5·30 } 88·85.
f Free SiO_2 = 80·50; Combined SiO_2 = 6·25 } 86·75.
g Free SiO_2 = 77·20; Combined SiO_2 = 7·55 } 84·75.
h + Organic matter.

Further similarity is shown in Table 6 in which the average of fourteen Hawkesbury Sandstone analyses is compared with Pettijohn's average of seven typical orthoquartzite analyses. The general agreement is marked, though the Hawkesbury Sandstone average does seem to have rather more clay cement which would account for the rather lower silica, higher alumina and higher MgO:CaO ratio. It is evident that as a lithologic type it is best described as an orthoquartzite.

The sandstones of the Wianamatta Group are also, with rare exceptions, lithologically consistent but the essential difference from the orthoquartzites of the Hawkesbury Sandstone is apparent even in hand-specimen, with colours varying from greenish to buff. The mineral grains show poor to medium sorting with grain-size variable between 0.1 and 0.2 mm. with occasional grains 0.3 mm. Most of the grains and fragments are angular with little or no orientation. The composition of the detrital mineral fraction is rather consistent. The minerals commonly present, together with percentage compositions determined with the Leitz integrating stage are:

Quartz: Angular and badly sorted grains vary in abundance between 10% and 20% with 15% as an average figure. One exceptional type from the Potts Hill Sandstone type locality had 50%. This quartz-rich type is confined to this one occurrence. Secondary (authigenic?) micro-mosaics of quartz occur in the matrix.

Feldspar: Both plagioclase and potash feldspars occur, although the plagioclase types are dominant. Sections are often quite fresh and were determined as soda-rich types, almost exclusively within the oligoclase range, in sections from all formations. The potash feldspars are always kaolinized but comparatively fresh microcline grains have been recognized in the Minchinbury Sandstone. The feldspar composition varies between 15% and 30% with about 20% as an average figure. Some of the exceptionally calcareous types have little or no feldspar. It seems very likely that the calcite has replaced and/or incorporated any feldspar originally present.

Siderite: Siderite grains and oolite-shaped aggregations are abundant in all the formations but are particularly abundant in the Minchinbury Sandstone. (Plate xii, figure 1.)

Glauconite: Scattered pellets of glauconite are found in all formations. All are length-slow and show olive-green →yellow-green pleochroism, medium relief and interference colours masked by the natural colour. Most sections show the glauconite replacing organic remains, often of ostracods.

Chlorite and *sericite* flakes are also found.

Rock fragments: Rock fragments, mostly sub-angular fragments of shaly material, vary between 5% and 20% of total constituents.

Iron-Oxide: Iron-oxide grains, mostly hematite varieties, are quite common. An exceptional type from the Minchinbury Sandstone near Menangle had 10% of hematite grains.

The matrix and cement comprises a considerable bulk of most sections varying between 25% and 60% of total constituents. The matrix may be of several types, any combination of which may comprise the total matrix of the rock.

Clay: A clay matrix is almost always present, varying between 10% and 50% of the rock.

Calcite: Calcite is always present, to a greater or less degree, in all sections. It can form anything up to 25% on an average, with many types from 25% to 60%. It is always interstitial and apparently of authigenic origin. Thin cracks and joints are often filled with calcite crystal aggregates.

Chlorite: Besides being of allogenic origin, some chlorite occurs as an authigenic mineral in the base commonly rimming, and apparently replacing, quartz grains (Plate xii, figure 3).

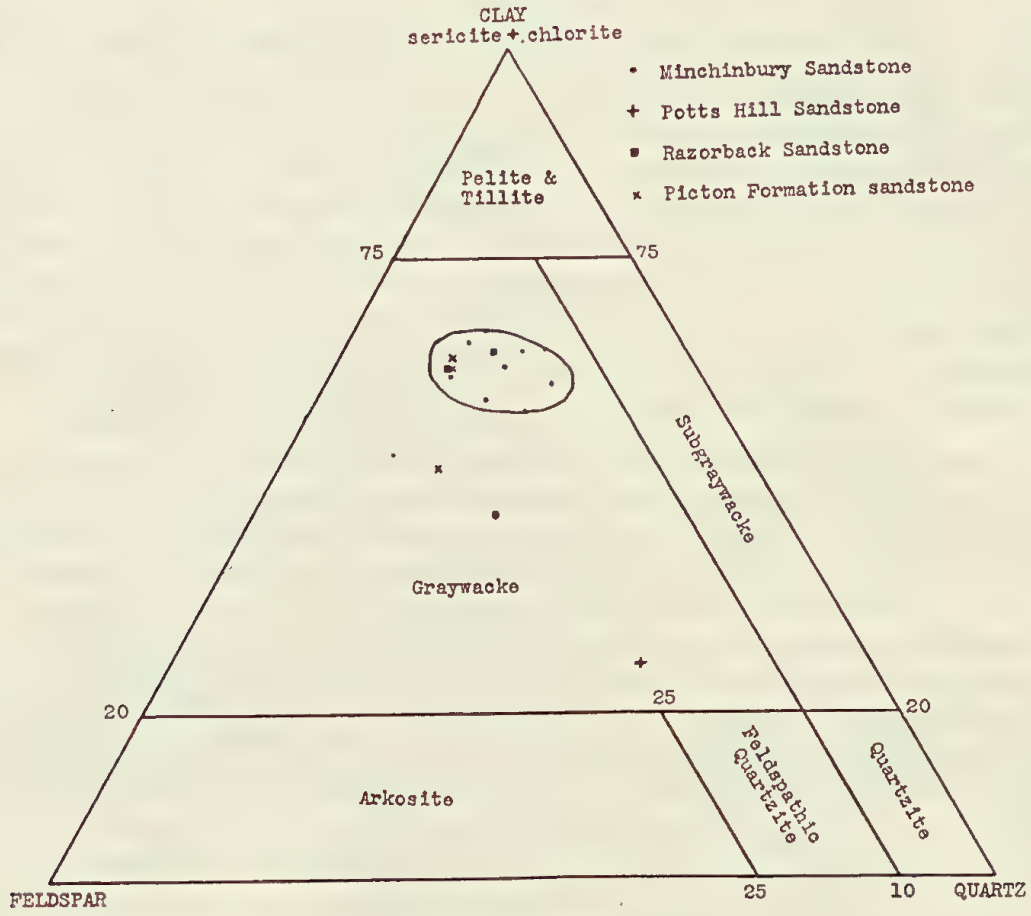


Fig. 5. Mineral composition of Wianamatta Group sandstone types plotted on Pettijohn's scheme.

A Classification of the Wianamatta Group Sandstones.

Plotting the detrital mineral composition on Pettijohn's tri-ordinate scheme (Figure 5) gives a field in which the greater majority of the analyses fall. The field lies in the top right-hand corner of the graywacke area and rather tending towards the subgraywacke area. Taking into consideration the general characteristics and lithologic association, it is intended in this discussion to use the term "graywacke-type sandstone" for the sandstones of the Group. The term is admittedly cumbersome but the fact that the rock type is not a typically high-rank graywacke, though it falls in the graywacke area, but shows tendencies towards the subgraywackes, is implied or at least suggested in the name.

For field description and the formational name, "sandstone" is still used, after careful consideration, as the all-embracing group name.

Some of the exceptional analyses outside the field are closer to the true graywackes. On the other hand a section of a Potts Hill Sandstone shows distinct relation to the fieldspathic quartzite area.

At this point, keeping in mind the problems met with in the identification of the Wianamatta Group sandstones, it is appropriate to consider:

The Graywacke Problem.

The group of sedimentary rocks known as the sandstones (or arenites, after Pettijohn) occupy an important position amongst the more common sedimentary lithologic types. In the literature, such terms as orthoquartzite, pure quartz sandstone, feldspathic sandstone, arkose, graywacke and subgraywacke have been applied to various members of the group. Of all these terms, graywacke has probably suffered most at the hands of careless workers and a confusing array of literature has arisen on the "correct" use of the term. Pettijohn (1949, p. 243-245) has given an excellent summary of this literature and concluded: ". . . graywacke is a petrographically distinct type of sandstone that is marked by its induration and dark colour. It is composed of large very angular detrital grains mainly quartz, feldspar, and rock fragments (mainly chert, phyllite, and slate). These grains are set in a prominent-to-predominant "clay" matrix which was, on low grade metamorphism, converted to a mixture of chlorite and sericite and partially replaced by carbonate."

A more rigid classification by Pettijohn, based on the mineralogical composition of the detrital fraction, gives the relation of the various members of the sandstone group (Figure 5). Such a scheme is extremely useful in the accurate classification of sandstone but it suffers to the extent that it presupposes an accurate determination of the clay, quartz and feldspar content of the rock.

Another problem to be overcome is the need for the further subdivision, on something more than arbitrary premises, of the comparatively large graywacke area. It is already becoming apparent that graywackes are not nearly as uncommon in the sedimentary record as was once thought. Indeed, as has been brought to light in this discussion, probably a large bulk of unusual types formerly described as tuffaceous sandstones are, in fact, graywacke types. From Figure 5 it is apparent that the usual type of Wianamatta Group sandstone lies within the graywacke field, but with definite affiliations with the subgraywacke field.

As it stands, then, the graywacke area by comparison with the other areas of the diagram is far too large for accurate definition of a lithologic type. However, any division at the present would lack precision and could only be attempted after a complete and exhaustive study of graywacke types from various occurrences. At the present time, without this information, it can only be suggested that there exists a basis for subdivision of the area into three parts. It seems a possible scheme that the fields be defined on the basis of the mineralogical composition of the three graywacke types characteristic of the tectotopes with which they are associated—geosynclinal, unstable intracratonic basin and unstable shelf. Future work may be profitably directed along these lines.

Chemical Discussion.

A number of analyses of Wianamatta Group sandstones have been collected and assigned to their appropriate formations.

Minchinbury Sandstone.—Six analyses of specimens from the Minchinbury Sandstone are listed in Table 7. The average analysis (7) has a very low silica percentage (38.48) and high CaO (18.92) and CO_2 (21.79) content. From the key to Table 7 it seems that this is due to the analysed specimens belonging to the marly constituent of the formation, a suggestion further substantiated by the great similarity in all constituents with the analysis of a marine marlstone (8) from the Ordovician of Ohio, U.S.A.

TABLE 7.

Analyses of Minchinbury Sandstone.

	1	2	3	4	5	6	7	8
SiO_2	51·00	34·65	41·15	38·46	34·93*d*	30·60	38·46	48·12
TiO_2	1·44	...	...	...	...	...	1·44	0·78
Al_2O_3	15·03	8·13*a*	10·45	8·00	2·71	13·75	11·08	12·80
Fe_2O_3	4·10	1·60	3·25	3·75	4·47		2·85	1·60
FeO	4·50	4·32					4·41	3·25
MnO	0·14	0·31	...	...	...	...	0·22	0·09
MgO	4·68	1·04	1·36	...	0·70	1·39	1·83	2·55
CaO	6·00	23·75	5·43	20·08	30·02	28·23	18·92	10·77
Na_2O	2·34	0·85	...	...	...	...	1·59	0·60
K_2O	1·89	1·07	...	...	...	...	1·48	3·60
H_2O+	5·48	3·15	1·23	...	2·71	...	5·48	3·25
H_2O-	...					0·92	0·92	1·70
P_2O_5	...	0·38	Tr.	...	Tr.	nil	0·38	0·65
CO_2	3·36	20·50	37·31*c*	20·08	24·78	24·72	21·79	9·19
S	...	...	...	...	...	...	...	0·88*f*
SO_3	...	...	nil	...	nil	nil	...	0·24
BaO	...	...	...	...	...	...	...	0·01
SrO	...	...	...	...	Tr.	...	Tr.	nil
Organic	...	0·25*b*	...	...	Tr.	0·39*e*	0·32	0·24
	100·36	100·00	100·18	...	99·78	100·00	100·06	100·36

a. Including any TiO_2 present.
b. Organic plus undetermined.
c. $CaCO_3$.
d. Insoluble matter—almost entirely coarse sand with a small quantity of clay.
e. Organic plus undetermined.
f. FeS_2.

1. "Calcareous clay-shale".—Minchinbury, Rooty Hill. *Ann. Rep. Mines Dept. N.S.W.*, 1907, p. 117. An. No. 7710.
2. "Argillaceous limestone".—1¼ miles west of Auburn. *Ibid.*, 1914, p. 216. An. No. 4379.
3. "Calcareous sandstone".—Near Granville. *Ibid.*, 1891, p. 59.
4. "Calcareous Wianamatta (Ostracodal)".—Grose Vale Road, Kurrajong to Richmond. Mines Dept. N.S.W. An. No. 3210/1802. Analyst, J. C. H. Mingaye.
5. "Limestone".—Near Sydney Water Supply Canal, Co. Cumberland. *Ann. Rep. Mines Dept. N.S.W.*, 1890, p. 50.
6. "Argillaceous limestone".—Prospect Dam, Prospect. *Ibid.*, 1889, p. 46. *See* Table 2.
7. Average, 1–6.
8. Marine marlstone (calcareous shale).—Shale components of Maysville, Ordovician Butler Co., Ohio. *Ohio Geol. Surv. Bull.* 42, p. 114. Analyst, D. Schaaf.

TABLE 8.

*Partial Analysis of Minchinbury Sandstone.**

$CaCO_3$	39·67
Clay	39·42
Fe_2O_3	2·69
$FeCO_3$	13·48
$MnCO_3$	0·43
$MgCO_3$	1·63
Alkalies (as chlorides)	0·68
H_2O	2·26
	100·24

* Minchinbury Sandstone ("limestone"). Duck Creek, Auburn. Smith, H. G., 1892.

A partial analysis of another marl type from Duck Creek is given in Table 8. A point of interest is the considerable percentage of siderite (13.48) in the analysis. Thin sections of the marly types show abundant, oolite-like siderite grains often aggregated together to form prominent blebs in the rock.

TABLE 9.

Analysis of Potts Hill Sandstone.

	1	2		1	2
SiO_2	68·64	69·69	K_2O	1·24	71
TiO_2	0·32	0·40	H_2O+	5·64	2·08
Al_2O_3	16·31	13·53	H_2O-		0·26
Fe_2O_3	3·90	0·74	P_2O_5	0·22	0·10
FeO	0·81	3·10	CO_2	...	0·23
MnO	0·04	0·01	O_2	Tr.	...
MgO	0·92	2·00	Organic	Tr.	...
CaO	0·68	1·95			
Na_2O	1·08	4·21		99·80	100·01

1. "Sandstone".—Por. 15. Ph. Picton, Co. Camden. *Ann. Rep. Mines Dept. N.S.W.*, 1924, p. 105. Analyst H. P. White. An. No. 3400.
2. Average of 3 Franciscan (Jurassic) graywackes—after Taliaferro. *Am. Assoc. Pet. Geol., Bull.*, vol. 27, 1943, p. 136. (Pettijohn, 1949, p. 250.)

Potts Hill Sandstone.—Table 9 lists an analysis of a sandstone from the south-east flanks of the Razorback Range (between Douglas Park and Maldon) which, in all probability, is referable to the Potts Hill Sandstone. The analysis was very similar to an average analysis of three Franciscan (Jurassic) graywackes quoted by Pettijohn (1949, p. 250) and included in Table 9. The agreement of the major constituents (silica and alumina) is very marked. The higher Fe_2O_3:FeO ratio of the Potts Hill Sandstone is probably explained by the specimen being weathered. This observation is lent further weight from the fact that the combined Fe_2O_3 and FeO content of both analyses (4.71 for 1; 3.84 for 2) is very similar. One point of difference is the rather high soda content of 2 which is not found in the Potts Hill Sandstone. The difference may be accentuated by the removal of some soda during the weathering process.

TABLE 10.

Analysis of Razorback Sandstone.

	Aa.	Bb.	Cc.		Aa.	Bb.	Cc.
SiO_2	73·72	77·8	64·2	H_2O+ ...	4·28	1·6	2·1
TiO_2	0·22	0·6	0·5	H_2O- ...		0·1	0·1
Al_2O_3	11·74	9·5	14·1	P_2O_5 ...	0·08	0·2	0·1
Fe_2O_3	4·60	0·9	1·0	CO_2 ...	..	0·5	1·6
FeO	0·81	2·6	4·2	SO_3 ...	Tr.	...	...
MnO	0·02	0·2	0·1	S ...	.	0·1	...
MgO	1·08	1·6	2·9	Organic	Tr.	0·2	...
CaO	0·44	1·2	3·5				
Na_2O	1·64	1·5	2·0				
K_2O	1·14	1·5	2·0		99·77	100·4	100·0

Aa. Razorback Sandstone ("Upper Sandstone"). Por. 15. Ph. Picton Co. Camden. *Ann. Rep. Mines Dept. N.S.W.*, 1924, p. 105. Analyst, H. P. White. An. No. 3399.
Bb. Average of 3 subgraywackes. Pettijohn (1949), p. 256.
Cc. Average of 5 graywackes. Pettijohn (1949), p. 250.

Razorback Sandstone.—An analysis of a sandstone (A) from the same locality as the analysed Potts Hill Sandstone, and most likely representative of the Razorback Sandstone, is listed in Table 10. This analysis has been chosen as a typical analysis of the Wianamatta Group sandstone type and in the table is compared with an average analysis of three subgraywackes (B) and five graywackes (C) quoted by Pettijohn (1949). The main point brought out in the comparison is that the analysis is midway between that of the subgraywacke, on one hand, the graywacke on the other. Comparing the key constituents, silica and alumina, it is immediately apparent that the Razorback Sandstone has a composition somewhere between them—in actual fact the analysis is almost exactly half-way between the two extremes, with a very slight tendency toward the subgraywacke.

This result is what would be expected when we recall the determination already made during the discussion of the mineral composition—the Wianamatta Group sandstones are somewhere between the true graywackes and subgraywackes in their constitution.

Preliminary Insoluble Residue and Heavy Mineral Data from the Minchinbury Sandstone.

Insoluble Residue Studies.—The calcareous nature of the Wianamatta Group sandstones lends itself to the techniques of insoluble residue studies and preliminary work has suggested that this technique may prove a useful tool in further stratigraphic work on the Group. The Minchinbury Sandstone, because of its wide geographic extent, may well be used for variation studies with insoluble residues.

TABLE 11

Analysis of Soluble and Insoluble Residue Minchinbury Sandstone.[a]

	Insoluble Residue.	Soluble Residue.	Combined.		Insoluble Residue.	Soluble Residue.	Combined.
SiO_2	29·38	1·22	30·60	P_2O_5	....	nil	nil
Al_2O_3	7·59	1·20	13·75	CO_2	...	24·72	24·72
Fe_2O_3		2·75		SO_3	...	nil	nil
FeO		2·21		Organic ...	...	0·39*b*	0·39
MgO	...	1·39	1·39				
CaO	0·40	27·83	28·23				
H_2O	...	0·92	0·92		37·37	62·63	100·00

a. "Argillaceous limestone".—Prospect Dam, N.S.W. *Ann. Rep. Mines Dept. N.S.W.*, 1889, p. ...
b. Organic and undetermined.

Table 11 gives an analysis of the soluble and insoluble portions of the Minchinbury Sandstone near Prospect.

Heavy Mineral Analysis.—A preliminary heavy mineral separation on a sample of the Minchinbury Sandstone from Kurrajong (Windsor 643517) showed that a definite mineral suite was available for study. It appears, from a preliminary examination by C. T. McElroy of the N.S.W. Geological Survey, that both stable (tourmaline, euhedral zircon) and unstable (garnet, monazite?, ferromagnesians) types are represented—a typical graywacke association.

Again, due to its wide areal extent, the Minchinbury Sandstone would probably provide an excellent basis for work on the lateral variation of the heavy mineral assemblage with the possibility that some extra light may be thrown on the source area of the sediments of the Group. It is hoped that future work may be directed towards this end.

The Sedimentary Environment and Sedimentary Tectonics.

Krumbein and Sloss (1951, p. 381) stressed the fundamental concept that any area of deposition may be classified according to the degree of tectonism prevailing during sedimentation. They defined two elements, one lithologic (Lithotope) and the other tectonic (Tectotope) to describe a lithologic sequence.

Lithotope: defined as an area of uniform sedimentation. This unit would be represented in the vertical co-ordinate of the columnar geologic section by a section of homogeneous lithology.

Tectotope: the tectonic subdivision representing a particular tectonic environment. This unit is represented in the geologic section by a section deposited during a consistent tectonic condition.

The two elements defined were used by Krumbein and Sloss to illustrate the depositional tectonic history of a section of Desmoinesian cyclothems in western Illinois.

The authors completed their concept by integrating the tectonic elements, lithologic association and geographic environment in their Tectono-environmental classification. On this basis it is a logical extension of the Lithotope-Tectotope concept to define a third element, the Environtope, to complete the description of an area of uniform sedimentation.

Envirotope: is defined as the environmental subdivision representing a particular depositional geographic environment. The units of the envirotope are those used by Krumbein and Sloss (p. 387) in their Tectono-environmental classification.

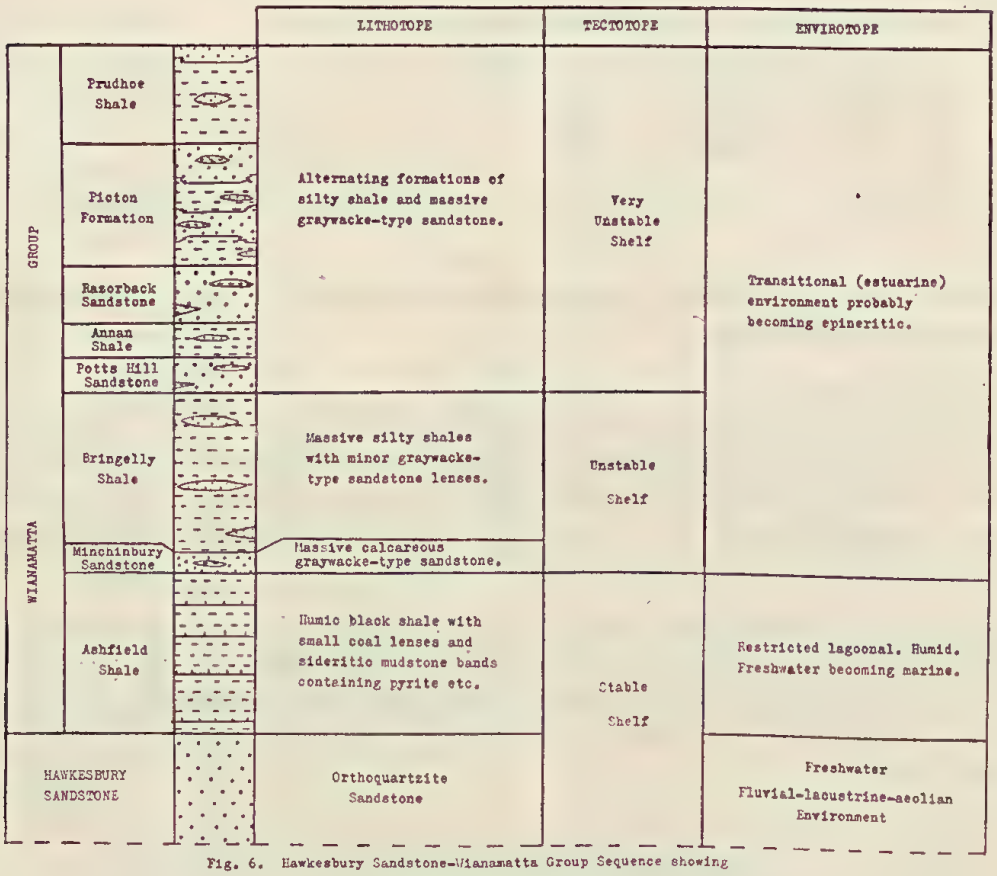


Fig. 6. Hawkesbury Sandstone-Wianamatta Group Sequence showing relation of observed lithotopes, inferred tectotopes and inferred envirotopes.

With the three elements we may determine the sedimentary environment of a lithologic sequence. Figure 6 indicates the relation of the observed lithotopes to the inferred tectotopes and envirotopes for the Hawkesbury Sandstone-Wianamatta Group sequence.

The underlying Hawkesbury Sandstone is a widespread, lithologically consistent, massive orthoquartzite—the characteristic sandstone type of the stable shelf tectonic area. Furthermore, taking into consideration (*a*) the wide geographic extent, (*b*) orthoquartzite lithologic type, (*c*) freshwater indication of the described fauna and evidence of fresh sub-surface waters, and (*d*) abundance of current bedding, it appears that the environment is essentially continental with fluvial-lacustrine-aeolian conditions all represented at some stage. Such an environment is essentially in agreement with the views of Osborne (1948). Actually it appears that considerable sediment was transported from the south-west, west and north-west (Osborne, 1948, p. xxx) and deposited in an immense delta area. The crustal stability, with little sinking, provided an area in which fluvial, now lacustrine, then aeolian conditions predominated. The result of all three environments is the Hawkesbury Sandstone with its abundance of rounded, well sorted quartz grains and stable-type heavy minerals. Occasional slumps

of the contemporaneously deposited shales formed the ubiquitous shale breccias, while old stream courses are probably represented by the coarser and pebbly bands found in the normal sandstone.

The change to Wianamatta deposition was through passage beds of alternating Hawkesbury-type Sandstone and Ashfield-type shale, probably representing an extension of the environment responsible for the dark shales in the Hawkesbury Sandstone. These passage beds do occur in all sheets but particularly in the Camden Sheet and other sheets to the south. Elsewhere the change is more pronounced and the Ashfield Shale appears to lie on contemporaneously eroded surfaces in the Hawkesbury Sandstone. The tectonic condition did not change noticeably in the passage—the shelf area was still stable with little sinking. On the other hand, the geographical environment did undergo considerable change. The conditions for the formation of the humic black shales with characteristic sideritic mudstone bands would suggest widespread lagoonal humid conditions with essentially restricted circulation. The abundant carbonaceous matter owes its preservation to rapid deposition of the associated fine sediment, a condition that implies increasing instability in the source area.

The environment suggests a fluctuating freshwater-marine area with definite tendencies to stabilize as marine. The evidence for a marine environment is discussed later, but here it is suggested by the observation that the described fauna of the Ashfield Shale, a freshwater fauna, is confined to a zone less than 100 feet above the Hawkesbury Sandstone. The general occurrence is of a great abundance of forms (molluscs, fish, etc.) tightly packed in vertically restricted zones indicating a catastrophic annihilation of the fauna—a condition most likely brought about, under the circumstances, by an influx of salt water. Other points which have led to this concept of fluctuating freshwater-marine conditions are: (*a*) The excellent state of preservation of the *Unio* shells suggests deposition in an environment of pH > 7. (i.e., the alkaline marine environment). In general, the slightly acid freshwater environment gives poorly preserved shells; (*b*) both pyrite and marcasite occur as authigenic minerals in the sideritic mudstone bands. Edwards and Baker (1951) have shown that authigenic pyrite is formed under alkaline conditions while authigenic marcasite needs acid conditions. This evidence indicates the delicate balance between the two environments.

The tendency appears to have been that marine conditions became increasingly regular and finally predominant after the Ashfield Shale deposition ceased.

The Minchinbury Sandstone and Bringelly Shale are discussed as a single lithotope—predominantly shale with subsidiary calcareous graywacke-type sandstone bands and lenses. A partly marine environment is proposed after consideration of the following facts:

(1) *The microflora and microfauna of the Minchinbury Sandstone.*—The evidence of the microfossil assemblage described previously (Lovering, 1953), consisting of marine-type arenaceous foraminifera, thin shelled ostracoda and algae, is indicative of definite marine conditions.

(2) *The lithologic types.*—The association of silty shale and graywacke-type sandstone is a typically marine lithology.

(3) *Salt content of the sub-surface waters.*—Old (1942) described a series of analyses of sub-surface waters from the Wianamatta Group rocks. The results

of the analyses indicate a consistently excessive salinity which, in some cases, is more saline than sea-water. Furthermore the salinity is not related or confined to any particular one of the formations.

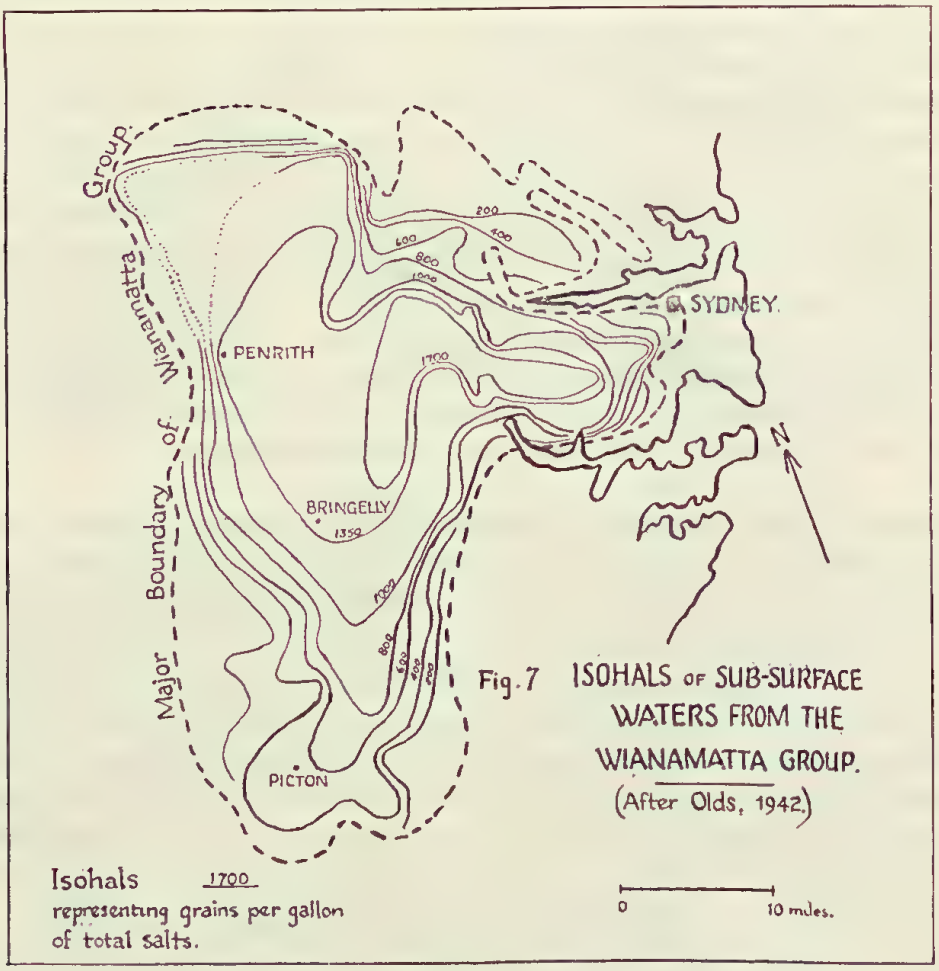


Fig. 7 ISOHALS OF SUB-SURFACE WATERS FROM THE WIANAMATTA GROUP. (After Olds, 1942.)

The most informative way of studying the lateral distribution of the salt is by drawing (after Old) a series of *isohals* which represent the maximum expectancy of salt content in various localities (Figure 7). It is apparent from the isohals that the salt content increases towards the central axis of the major structural basin where the maximum Wianamatta Group thickness is found and also where the group extends farthest below sea-level. It is an important feature that the 400 isohal bulges to include the great thickness represented by the Razorback Range.

This salt must represent connate salt, that is, salt derived from the marine waters of the depositional area included and retained by the shales because of a particular set of conditions: (*a*) Impervious nature of the shales: assisted retention; (*b*) low relief, little natural drainage of the basin: served to concentrate the salt.

The presence of considerable magnesium as well as sodium salts, together with the alkaline pH, both characteristics of present-day sea-water, strengthens the connate origin. On the other hand, the acid, non-saline waters from the Hawkesbury Sandstone are in turn in accord with the freshwater origin of that formation.

The lithologic association and microfossil assemblage suggest that transitional (fluvial-lagoonal-littoral) environment of Krumbein and Sloss (1951) with estuarine or even shallow wave and current-agitated marine water (epineritic) conditions predominating.

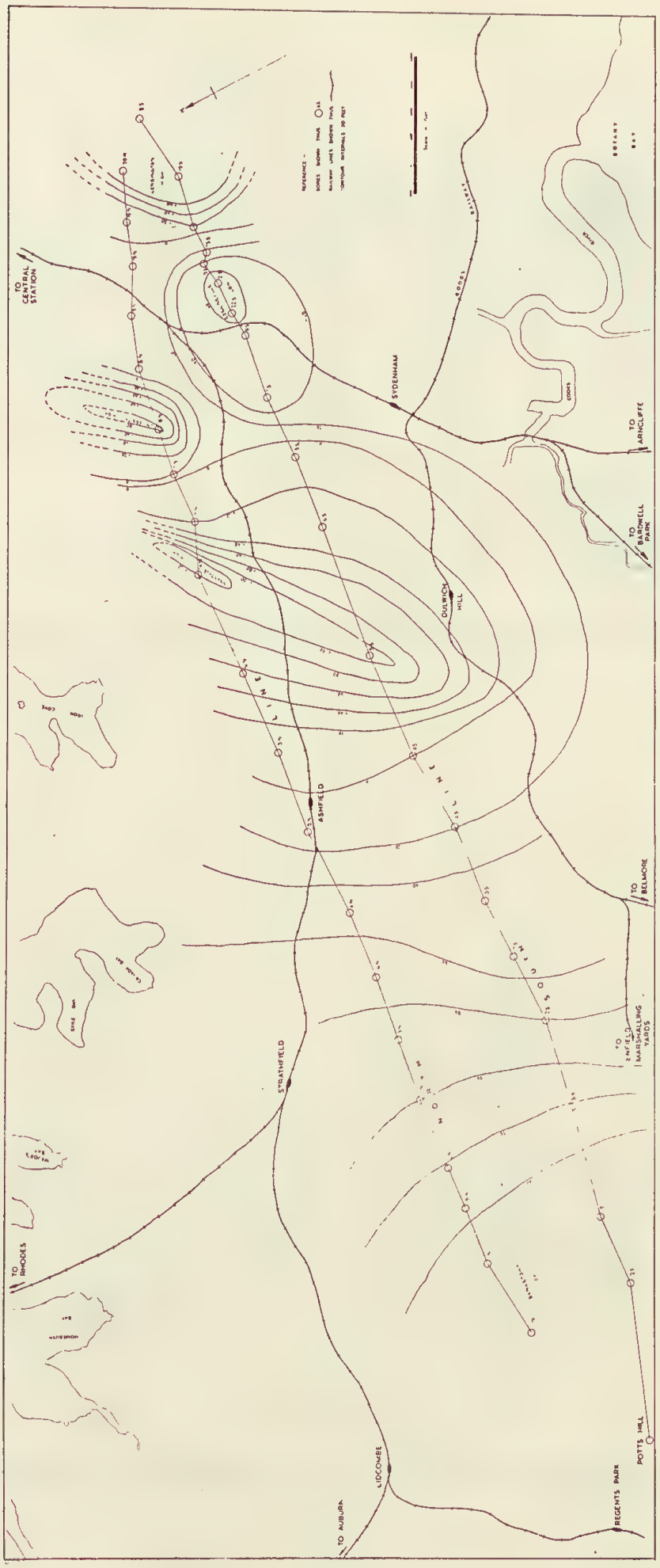


Fig. 8.—Structure contours on the base of the Wianamatta Group. Data from north and south lines of bores for M.W.S.D.B. City Tunnel exploration.

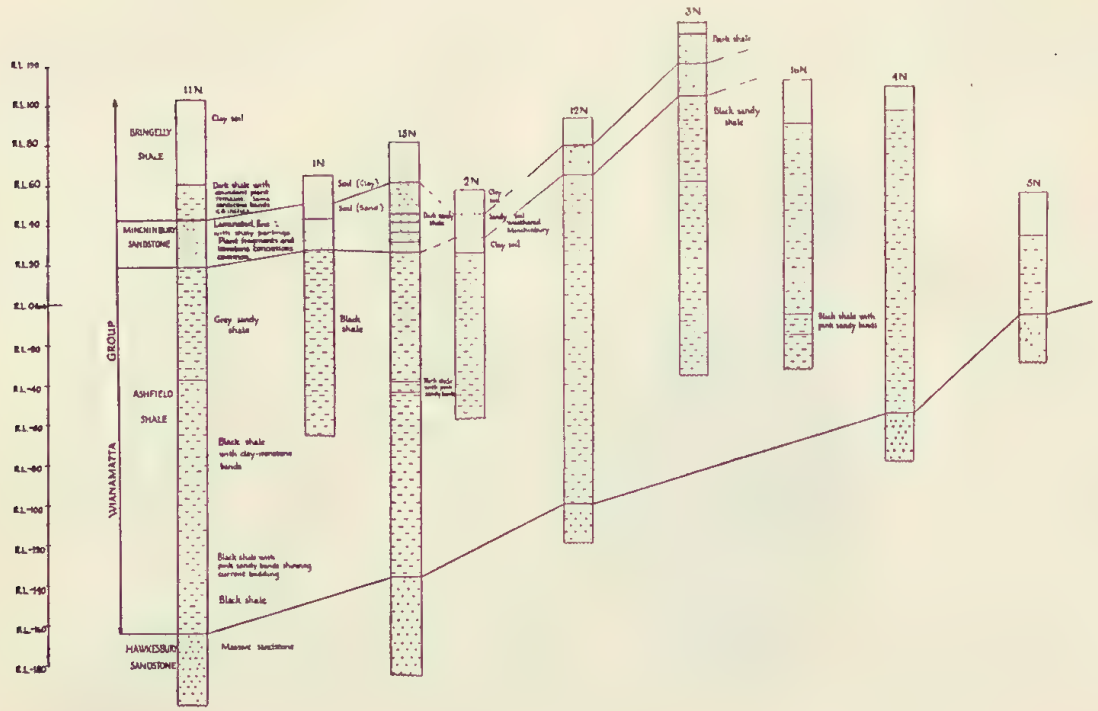


Fig. 9.—Sub-surface data from north line of M.W.S.D.B. City Tunnel exploratory bores. (Plan of bores shown on Fig. 8.)

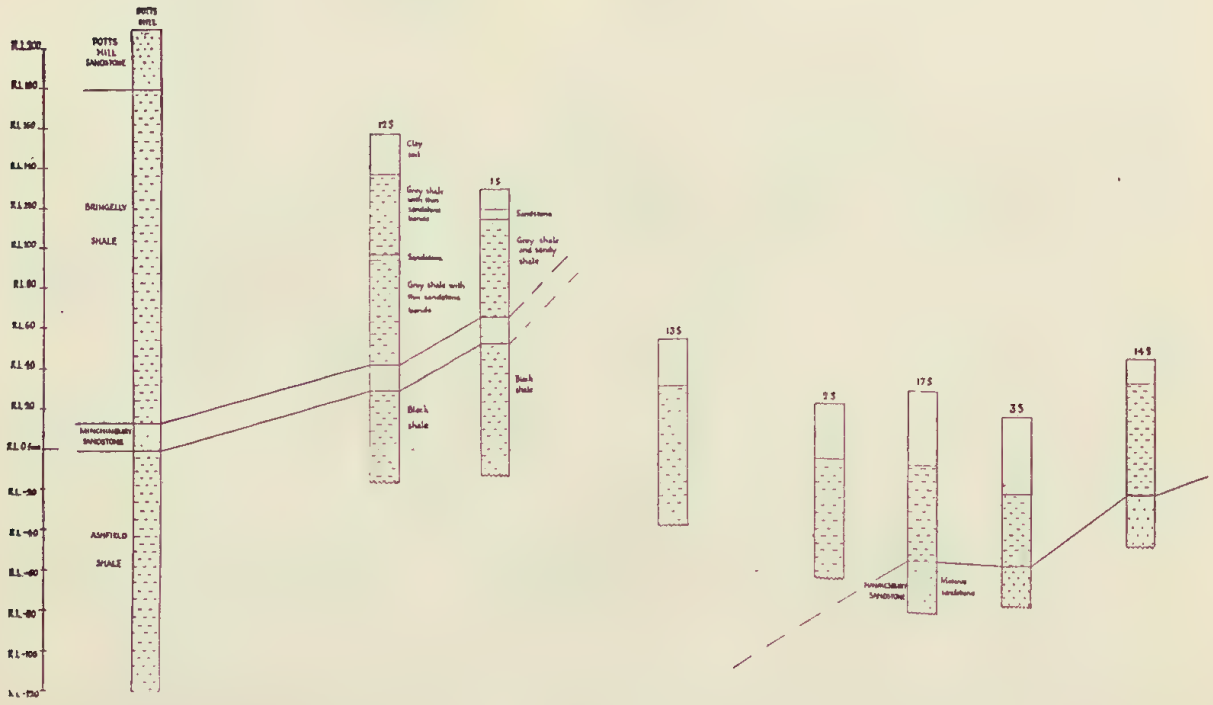


Fig. 10.—Sub-surface data from south line of M.W.S.D.B. City Tunnel exploratory bores (This line follows the actual tunnel. Plan shown on Fig. 8.)

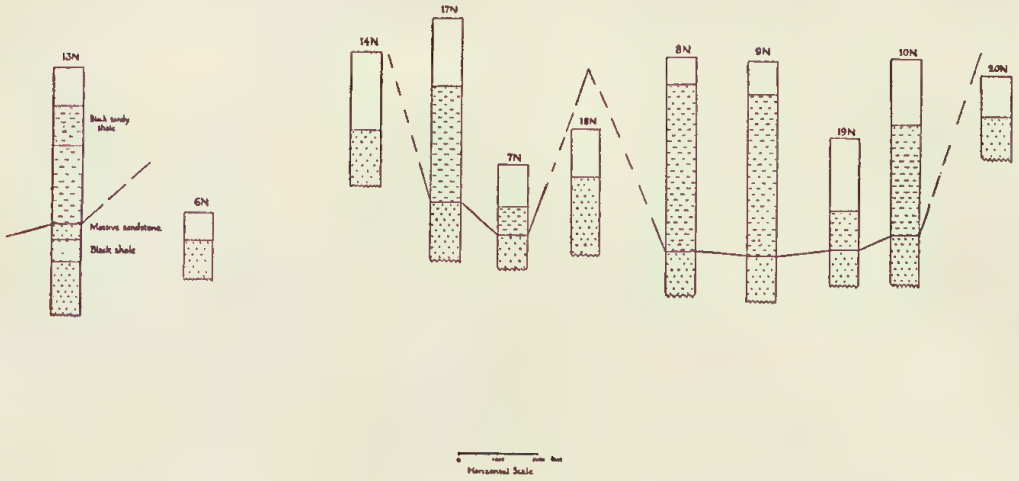


Fig. 9 (*contd.*)

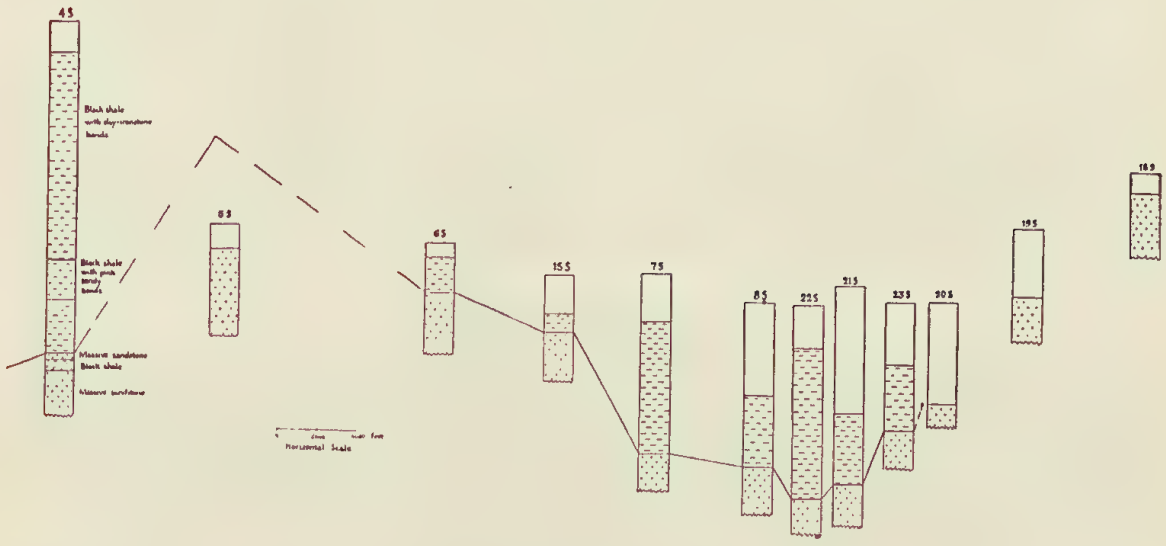


Fig. 10 (*contd.*)

The appearance of graywacke-type sandstones in the section gives the first indication of a changing tectonic condition—instability of the shelf area. The occasional quartz-rich sandstones found in localized areas suggest an area, such as a channel or shore line, in which conditions are relatively turbulent with a tendency to "clean-up" the original graywacke sediment. The abundance of calcite in some sandstones which, in some cases, causes the rock to become rather an argillaceous limestone, is characteristic of such a depositional area of tectonic instability and estuarine environment which allows free mixing of clastics and non-clastics.

The conditions acting during the deposition of the formations of the Camden Sub-group are an extension and consolidation of those operating during the Minchinbury Sandstone-Bringelly Shale deposition. The environment is still estuarine (transitional) with a tendency towards the shallow, open-circulation marine (epineritic) condition. The shelf area has consolidated as very unstable and the oscillatory movements, causing fluctuations of the strand line, have formed the rather complex association of massive graywacke-type sandstone and shale formations.

The illustration of the sequence shown in Figure 6 is, in broad outline, almost identical with the "mixed sections" of Pettijohn (1949, p. 461) in which the sequence is composed of formations belonging to several contrasting facies but with a particular arrangement. The sequence of the Huronian of Michigan is a typical example:

(1) Lower Huronian: orthoquartzite-limestone facies. cf. Hawkesbury Sandstone.

(2) Middle Huronian: an anerobic facies—thin basal orthoquartzite with overlying sideritic black shale and cherty iron carbonate. cf. Ashfield Shale.

(3) Upper Huronian: basal conglomerate followed by a very thick series of Flysch-like slates and graywackes. cf. Minchinbury Sandstone, Bringelly Shale and Upper Division formations.

The Palaeozoic of the Ouachita and Arbuckle Mountains is similar to the Huronian section, even to minor details of lithology.

It then appears that this sequence is not uncommon in the sedimentary record of the world and does represent a particular set of recurrent conditions reminiscent of the ideal cyclothem, but on a much larger scale. The Hawkesbury Sandstone-Wianamatta Group sequence forms a connecting link with the Huronian large scale section and the cyclothem small scale section.

The tectonic environment is essentially a shelf area originally stable but rapidly becoming increasingly unstable and reaching the peak of its rhythm in the upper part of the sequence. Such a condition probably represents a stage in the orogenic cycle possibly related to the initial stages of the development of a geosyncline from a shelf area.

Post-Depositional Tectonics.

The post-depositional tectonic history of the Wianamatta Group is bound up with the tectonic vicissitudes of the whole Sydney Basin. Willan (1925) in his Sydney District map shows contours with 100-feet interval on the base of the Wianamatta and again on the top of the Upper Coal Measures. The two structure contour maps are basically very similar and a series of domes and basins are shown and named, e.g., Botany Basin, Fairfield Basin, Penrith Basin and Mulgoa Dome.

Countless minor faults and warps are found in the Ashfield Shale and other formations, but occasional major displacements with crushed zones up to 20 feet have been exposed in the driving of the Metropolitan Water, Sewerage and Drainage

Board's City Tunnel. The major structural feature affecting the Wianamatta Group is the Glenbrook Monocline and associated tectonic features apparent in the western edge of the Cumberland Basin. The problem of this feature and its associated physiographic effect is fully considered by Osborne (1948, p. xxxiii) and is not repeated here.

Some detailed work on the basin has been carried out in the western suburbs of Sydney with information provided by a series of exploratory bores sunk by the M.W.S.D.B. The location of the bores is given in Figure 8, together with structure contours (contour interval 20 feet) on the base of the Ashfield Shale. The logging of the two lines of bores is shown in Figures 9 (North Line) and 10 (South Line) together with the lithology of the represented formations. The profile of the basin is also shown and its irregular outline is at once apparent. The structure contour plan does give a picture rather different from that of Willan's map, mainly by reason of more data and smaller contour interval. The structure is much "tighter" in the central area than has previously been recognized, with a series of highs and lows in a relatively short horizontal distance.

The western boundary is the rather shallow basin-like structure of the Bankstown Low. Moving to the east the structure becomes gradually "tighter" with a pronounced high at Annandale (the Annandale High) and another centring on Sydney University (the University High) with a shallow basin to the south-west (the Erskineville Low). The eastern margin of the drawing is formed by another dome structure, the Kensington High.

The information gained in this rather restricted area indicates a complexity of tectonic structure which has not so far been recognized. In a plan for future work in the northern suburbs of Sydney it is intended to extend the contour plan on the Wianamatta Group-Hawkesbury Sandstone boundary.

The joint pattern imposed on the rocks by tectonic conditions is of interest. Two major sub-vertical (80-90°) systems N.30° W. and N.55° E. have been recognized. This pattern must have originated before the Tertiary igneous activity—the basic dykes strike along these directions and have been intruded into them.

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Explanation of Plate XII.

1. Siderite aggregates in the Minchinbury sandstone. (A.M. 5700.) X 20.

2.—The typical graywacke-type sandstone of the Minchinbury sandstone. Angular quartz, altered feldspar and rock fragments in a matrix of calcite and clay. (A.M. 5699.) X 20.

3.—A graywacke-type sandstone from the Picton formation. Angular quartz (with chlorite rims), altered and fresh oligoclase, rock fragments in a clay and calcite matrix. (A.M. 5730.) X 20.

4.—A graywacke-type sandstone from the Picton formation (cf. Fig. 3). (A.M. 5731.) X 20.

5.—Junction of Hawkesbury sandstone and Ashfield shale, Liverpool Golf Course.

6.—Minchinbury sandstone overlain by Bringelly shale. Bonnyrigg (Liverpool 867137).

7.—Potts Hill sandstone. Potts Hill Quarry.

8.—Sugarloaf Hill (Camden 775875) showing capping of Razorback sandstone (1), with Annan shale (2), Potts Hill sandstone (3) and Bringelly shale (4).

AN ANNOTATED BIBLIOGRAPHY OF THE POISONOUS AND VENOMOUS FISHES OF AUSTRALIA

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Foreword.

In 1943 the Council for Scientific and Industrial Research, in Melbourne, published its Bulletin No. 159, "Poisonous and Harmful Fishes." This Bulletin was originally intended for use by His Majesty's Forces in World War II. In the foreword to that publication it was stated that a more detailed report and a bibliography on the same subject had been assembled for separate publication. No further edition of the Bulletin has been issued, but separate articles on poisonous fishes have appeared. In view of the increased interest in the subject by scientific organizations in the United States, Japan and the Pacific Islands, it was deemed advisable to publish the present bibliography.

The literature of medical ichthyology is extensive and widely scattered throughout scientific journals in a variety of languages. Since a review of the world literature on toxic fishes is not feasible at this time, the present work has been limited chiefly to those publications concerned with the poisonous and venomous fishes of Australia. The term fishes is used in the zoological sense and does not include such invertebrates as jellyfish, shellfish, etc. It will be noted that a number of articles have been listed under the section entitled "General". The works listed in this section are concerned with the more general aspects of the problem of toxic fishes and would be pertinent to a discussion of any area. Papers containing articles on both poisonous and venomous fishes have also been listed in the general section. The remainder of the references have been segregated into the two categories "Poisonous Fishes" and "Venomous Fishes." The term poisonous fishes refers to those whose flesh when ingested by human beings produces toxic symptoms. In contrast, venomous fishes produce their injurious effects by injecting their venom by means of stings or spines. In the latter case the injury is associated with mechanical trauma.

In some instances, e.g., tetraodon poisoning, stingrays, catfishes, etc., it was felt advisable to include certain additional basic papers which were considered to have a bearing on the subject under consideration even though they were not concerned directly with Australian species. It is the hope of the authors that this contribution will stimulate others to conduct research in this greatly neglected field.

GENERAL PAPERS.

Anonymous.

1944.—Survival on land and sea. Office of Naval Intelligence, U.S. Navy: 48-52, 1 fig.

Vernacular names and brief popular descriptions are given for some of the more poisonous and venomous fishes. Precautionary measures are suggested relative to ingesting and handling tropical fishes.

Blanchard, R.

1890.—Traité de zoologie médicale. J. B. Bailliere et Fils, Paris, 2: 638-695.

Poisonous, venomous, and electric fishes are briefly discussed. Scientific names are given for a number of species which have been reported dangerous to man.

BOULENGER, G. A.

1904.—Fishes. Cambridge Nat. Hist., Macmillan, London, 7 (21): 589-591, 705, 724, 726.

References are made to poisonous, venomous, and electric fishes. Boulenger disagrees with some authors on the poison-organ of *Noturus*, but considers *Trachinus* species to be venomous. Puffers (five genera named) and *Monacanthus* species may be poisonous.

CILENTO, R. W.

1944.—Some poisonous plants, sea and land animals of Australia and New Guinea. Smith and Paterson, Brisbane: 23-27.

A general discussion of toxic fishes with quotations from recent authorities concerning various species. *Synanceja horrida, Notesthes robusta, Dasyatidae* spp., and *Netuma* spp. are named as venomous. *Tetrodon* spp. and *Paradicichthys venenatus* are named as poisonous.

CLELAND, J. B.

1912.—Injuries and diseases in man in Australia attributable to animals (except insects). *Australasian Med. Gaz.*, 32 (11, 12): 269-274, 297-299.

A collection of cases involving poisonous and venomous fishes as well as other sea and land animals. Effects of a bite or sting from several species of venomous fishes are included, but the only poisonous fishes named are *Tetraodon* and *Diodon* spp.

1932.—Injuries and diseases in Australia attributable to animals (other than insects). Ser. 4, *Med. Jour. Australia*, 1 (19): 159-160.

Specific cases are given of injury from stingrays, stone-fish, and the spike of the bugler fish. One case concerns a poisonous fish and its effect on the persons who ate it.

1942.—Injuries and diseases in Australia attributable to animals (insects excepted). Ser. 5, *Med. Jour. Australia*, 2 (14): 314-315.

Recent cases are listed of attacks by sharks and stingrays, bites from a kingfish and a green eel, and poisoning after eating *Callionymus calauropomus* and *Paradicichthys venenatus*. Symptoms and treatment are mentioned briefly under the last-named fish.

COLBY, M. J.

1943.—Poisonous marine animals in the Gulf of Mexico. *Proc. Trans. Texas Acad. Sci.*, 26: 62-70.

Poisonous and venomous fishes are discussed briefly under those divisions. Puffers, porcupine fish, barracuda, herrings, and gars have been named as poisonous. Venomous fishes include *Muraena*, sting rays, scorpionfishes, and catfishes. Some invertebrates (jellyfish, mussels, and echinoderms) are also mentioned.

COUTIÈRE, H.

1899.—Poissons venimeux et poissons vénéneux. Thesis, Paris, School of Pharmacy.

Poisonous and venomous fishes are listed without comment if they had been previously incriminated. Effects of the poison or venom are discussed in a scientific manner, and cases are cited. It includes some experimental data on fish poisons. One of the more valuable early works.

DEAN, B.

1916-23.—A bibliography of fishes. Amer. Mus. Nat. Hist., New York. Vol. 1 (1916), 2 (1917), and 3 (1923).

A comprehensive collection of references to poisonous and venomous fishes appears in the index volume (Vol. 3) on pages 572-574.

FAUST, E. S.

1906.—Die tierischen Gifte. Friedrich Vieweg und Sohn, Braunschweig: 134-165.

A scientific presentation of experiments and data on poisonous and venomous fishes. Various types of intoxications are discussed.

1924.—Tierische Gifte: Fische, Pisces. *Handbuch Exp. Pharm.*, Berlin, 2 (2): 1841-1854.

This article is essentially the same as the above.

GUDGER, E. W.

1930.—Poisonous fishes and fish poisonings, with special reference to Ciguatera in the West Indies. *Amer. Jour. Trop. Med.*, 10 (1): 43-55.

A review of data on venomous and poisonous fishes. *Siluridae, Scorpaenidae,* weevers and stingrays are listed as having venomous stings, but the toxicity of *Muraena* bites is questioned. Eel and fish blood is mentioned as a poison. Fishes which are named as poisonous to eat are *Sphyraena barracuda, S. picuda, Tetrodon maculata,* and *Clupea venenosa.* The clinical characteristics of Ciguatera are described and the Japanese studies of Tetrodontoxin are summarized. An important basic work.

GÜNTHER, A. C.

1880.—An introduction to the study of fishes. Adam & Charles Black, Edinburgh: 189-192, 3 figs.

Poisonous fishes (*Clupea, Tetrodon, Sphyraena, Balistes, Ostracion, Caranx, Thynnus*, etc.) are said to become toxic through their diet. Venomous fishes mentioned are the stingrays, Scorpaenids, *Trachinus, Synanceia, Thalassophryne*, and perhaps some Silurids. Brief anatomical descriptions are given of the venom organs of some species.

HALSTEAD, B. W.

1951.—Poisonous fish—a medical-military problem. *Research Reviews* (Office of Naval Research, Washington, D.C.), June: 10-16, 8 figs.

A general review of fish poisoning and its relationship to the armed forces. The clinical characteristics of the disease and theories as to the cause of fish poisoning are reviewed.

1953.—Some general considerations of the problem of poisonous fishes and ichthyosarcotoxism. *Copeia*, (1): 31-33.

A general review of the problem of fish poisoning. The article is primarily concerned with definitions of terminology.

JORDAN, D. S.

1905.—A guide to the study of fishes. Henry Holt and Co., New York, vol. 1: 182-185; vol. 2: 335, 411, and 413.

Fish poisoning is considered as a defensive measure for the fish. Ciguatera is attributed to an alkaloid. Some poisonous fishes are named.

KOBERT, R.

1902.—Ueber Giftfische und Fischgifte. *Med. Woche*, (19-21): 199-201, 209-212, 221-225.

A report on poisonous and venomous fishes: scientific names, types of poisoning, and causes of poisoning. General information from a wide variety of sources is included.

LEA, A. M.

1903.—The poisonous and stinging animals of Tasmania. Folding sheet, reprinted from the *Tasmanian Mail* (November): unpaged, 16 figs.

Illustrates Toadfish and Soldier Fish [*Pentaroge*]. Case of poisoning through eating Whiting (*Sillago*).

MAASS, T. A.

1937.—Gift-tiere. Tabulae biologicae (ed. by W. Junk). W. Junk, The Hague, 13: 193-214.

A systematic tabulation of poisonous and venomous fishes and their poisons.

MACHT, D. I., and E. C. SPENCER.

1941.—Physiological and toxicological effects of some fish muscle extracts. *Proc. Soc. Exp. Biol. Med.*, 46 (2): 228-233, 1 tab.

The pharmacological effects of fish muscle extracts are reported. Preliminary experiments on plants and mice indicated that the following fish had toxic flesh: *Ameiurus catus, Anguilla chrisypa, Vomer setipinnis, Diodon hystrix, Spheroides maculatus, Pteroplatea maclura, Mustelus canis, Dasyatis say*, and *Opsanus tau*. Experimental techniques for use in testing fish extracts are given.

MOSSO, A.

1888.—Un venin dans le sang des Murenides. *Arch. Ital. Biol.*, 10: 141-169.

A scientific account of a wide variety of experiments to determine the properties of eel and moray blood. The serum is found to be toxic when injected. An important basic work.

NORMAN, J. R.

1931, 1936.—A history of fishes. Ernest Benn, Ltd., London, ed. 1 (1931); ed. 2 (1936): 140-145, 3 figs.

A general summary of basic information on poisonous and venomous fishes.

PAWLOWSKY, E. N.

1927.—Gifttiere und ihre Giftigkeit. Gustav Fischer, Jena: 245-247 (figs. 114, 115), 406-418 (figs. 166-170), and 478-481.

An excellent general work on poisonous animals, containing comprehensive sections on poisonous and venomous fishes. It is particularly good on the anatomy of the venom organs of fishes. Excellent bibliography.

PELLEGRIN, J.

1899.—Les poissons vénéneux. Thesis 510. Ollier-Henry, Paris: 1-121, 16 figs.

A comprehensive systematic review of poisonous fishes. Only brief mention is made of venomous fishes. Numerous case histories are included and treatment is discussed.

PHISALIX, M.

1922.—Animaux venimeux et venins. Masson et Cie., Paris, 1: 487-628, figs. 194-232, pls. 4 and 5.

The most comprehensive work in existence on the general subject of poisonous and venomous animals. It contains a great deal of experimental data and an excellent bibliography.

1931.—Prophylaxie et traitement des piqûres venimeuses de poissons. *Notes,* Station Océanogr. Salammbô, No. 23: 1-6.

A scientific account of the properties of fish venom. Treatment for fish stings is described.

PRYOR, J. C.

1918.—Naval hygiene. Blakiston, Philadelphia: 153-155, 309-318, 2 figs.

A general report on toxic fishes as they relate to naval personnel. It lists about two dozen important species.

SAVTSCHENKO, P.

1886.—Atlas des poissons vénéneux, descriptions des ravages produits par eux sur l'organisme humain, et des contre-poisons à employer. (Text in Russian and French.) St. Pétersbourg: 1-55, 19 pls.

One of the most complete of the early works on poisonous and venomous fishes. It contains a general discussion of the problem, descriptions and figures of about 45 species. An important work.

SCOTT, H. H.

1921.—Toxicology. The practice of medicine in the tropics (ed. by W. Byan and R. G. Archibald). Frowde and Hodder and Stoughton, London, vol. 1, sect. 6: 790-798, pls. 34-35, and figs. 323-327.

Some of the better-known species of poisonous and venomous fishes are discussed. Figures are supplied to assist the general reader in identifying dangerous fishes.

STRONG, R. P.

1944.—Stitt's diagnosis, prevention and treatment of tropical diseases, 7th ed. Blakiston, Philadelphia, 2: 1544-1547, 1 fig.

Several poisonous and venomous fishes are named with general comments on their effects. Those considered poisonous are *Tetrodon, Diodon,* and *Meletta* species, and barracuda. Venomous fishes listed are *Muraena, Trygon, Trachinus,* and *Scorpaena.*

TENISON-WOODS, J. E.

1882.—Fish and fisheries of New South Wales. Thomas Richards, Sydney: 30-91.

This chapter on marine food fishes contains many scattered references to poisonous and venomous fishes. It is written primarily from the standpoint of the angler.

TYBRING, O.

1887.—Poisonous fish. *Bull. U. S. Fish. Comm.,* 6 (1886): 148-151.

Cases of fish poisoning are cited from many parts of the world, naming the fish involved where possible. Venomous fishes are only casually mentioned. The paper is too general to be of great value.

WHITLEY, G. P.

1930.—Ichthyological miscellanea. *Mem. Queensland Mus.,* 10 (1): 8-31, 1 pl., 1 fig.

Brief reference is made to the occasional toxicity of *Paradicichthys venenatus,* and to the work of Duhig and Jones on the venomous properties of Australian stonefish (*Synanceja* spp.).

1940.—Fishes of Australia. Sydney and Melbourne Pub. Co., Sydney, Part I: 63, 153, 194-199.

The book deals with sharks, rays, and fish-like animals. Venomous properties of *Trygon, Scorpaena,* and *Trachinus* are mentioned. Reference is made to the purgative and toxic effects of shark flesh.

1943.—Poisonous and harmful fishes. *Council Sci. Indust. Res. Bull. No. 159,* Melbourne: 1-28, 3 pls., 16 figs.

Popular descriptions are given of all common poisonous or venomous fishes of Australia or the south-western Pacific. A practical guide to protect those who have not studied toxic Australian fishes.

POISONOUS FISHES.

ANDERSON, W.

1776.—An account of some poisonous fish in the South Seas. *Philos. Trans. Roy. Soc., London*, 66: 544-552.

One of the first published accounts of fish poisoning in the South Seas. It gives a clinical résumé of an outbreak involving several persons poisoned from eating *Sparus pagrus*, and it states that Captain Cook was poisoned from eating a *Tetraodon*.

ANONYMOUS.

1821.—*Sydney Gazette* (April 21): 2, 3.

Coroner's inquest on man poisoned by toadfish at Parramatta.

1831.—*The Colonial Times*, Hobart (March 29, April 5).

Coroner's inquest on three victims of toadfish poisoning.

1831.—*Sydney Herald*, 1 (1): 4.

Toadfish poisoning at New Town, Tasmania.

1839.——Barracouta of the West Indies. *Nautical Magazine*, 8: 256.

Silver test not infallible.

1871.—Editorial on *Tetraodon hamiltoni*. *New South Wales Med. Gaz.*, 1 (10): 305-309.

The author warns against eating *Tetraodon hamiltoni* and summarizes several cases of poisoning from eating it and other *Tetraodon* species.

1874.—Poisonous fish. *Sydney Morning Herald* (July 7): 5.

Lady had convulsions from eating fish—blackfish, garfish and trout—from Sydney, at Wagga, 2/7/74. Recovered.

1899.—The "Palu" or "oil-fish" of Funafuti. *Nature*, 60 (1561): 536.

A brief note giving a popular description of the oilfish and identifying it as *Ruvettus pretiosus*, which is well-known for its purgative properties.

1943.—Poisonous and Dangerous Fishes of the Tropical Pacific. Prepared by the Arctic, Desert and Tropic Information Center, Eglin Field, Florida. *Informational Bulletin* A, 11: 1-15, illustr.

A guide for servicemen.

1950.—*Daily Telegraph* (newspaper), Sydney (December 9-12).

Toadfish poisoning.

1951.—*Sydney Morning Herald* (March 6).

Woman dies, family ill, after eating toad fish.

1951.—*Sun* (newspaper), Sydney (March 7): 14.

Same as 1950, 1951 cases.

AUTENRIETH, H. F.

1833.—Ueber das Gift der Fische. C. F. Osiander, Tubingen: 1-287.

Fishes which had been reported as poisonous are enumerated with comment. Much of the book is devoted to a semi-popular account of fish poisons. A useful work.

BACKHOUSE, J.

1843.—A narrative of a visit to the Australian colonies. Hamilton, Adams, London: 186-187.

Toadfish poisoning, Hobart, 1831.

BENNETT, G.

1871.—On the "toad fish" (*Tetraodon hamiltoni*) of New South Wales. *New South Wales Med. Gaz.*, 1 (6): 176-181, 1 pl.

A figure and description of *Tetraodon hamiltoni* are given with a warning against eating it. Several cases are cited of poisoning from eating *Tetraodons*.

BRENCHLEY, J. L.

1873.—Jottings during the cruise of H.M.S. "Curaçoa" among the South Sea Islands in 1865. Longmans, Green and Co., London: 60, 135, 200, 213, 214, 231.

Random notes are included on poisonous fishes at the various South Sea Islands. The work is of minor importance.

BURROWS, W.

1945.—Periodic spawning of "palolo" worms in Pacific waters. *Nature*, 155 (3924): 47-48.

The author states that reef fishes become poisonous for 10 to 14 days after the swarming of the palolo worm.

CILENTO, R. W.

1940.—Tropical diseases in Australasia. Smith and Paterson, Brisbane: 339-340.

Chapter 16 was slightly revised and published as "Some poisonous plants, sea and land animals of Australia and New Guinea (notes for medical nursing and ambulance staffs)." Brisbane, 1944: 23-25. Notes treatment of wounds from venomous fishes and for toadfish and chinaman fish poisoning.

COOK, J.

1777.—A voyage towards the South Pole and around the world, ed. 3, London, 2: 112-113.

This is one of the first published experiences concerning poisonous fish. Captain Cook described the predominant symptoms and treatment of his illness after eating a fish "something like a sunfish" [now known as a puffer, *Pleuranacanthus sceleratus*].

CROWTHER, W. E. L. H.

1954.—The Rontgen Oration. Practice and personalities at Hobart Town, 1828-1832, as indicated by the Day Book of James Scott, M.D., R.N., Senior Colonial Surgeon. *Med. Journ. Austr.*, 1, 41st year, 12: 421-430, figs. 1-8.

Toadfish poisoning in Tasmania.

DALRYMPLE, A.

1775.—An historical collection of the several voyages and discoveries in the South Pacific Ocean. J. Nourse, London: 1, 140-141.

Early English translation of Quiroz's account of men having been poisoned by pargos in 1606.

DEMPSTER, G. O. L.

1949.—Fish poisoning. *Brit. Med. Jour.*, 1 (4608): 775.

The author takes issue with the theory that fishes become toxic because of the dumping of war matériels, stating that he saw entire villages in the South Pacific sick with fish poisoning during the 1930's. He believes fish become poisonous as a result of eating a poisonous marine growth.

DEWBERRY, E. B.

1938.—Food Poisoning. *Food Manufacture*, London, 13, 8, Aug., 1938: 275-276.

Brief mention of symptoms of fish poisoning and signs of decomposition in fish.

DUMERIL, A.

1866.—Des poissons vénéneux. *Ann. Soc. Linn. Depart. Maine-et-Loire*, 8: 1-17.

This article in English translation appeared as follows:

1867.—On venomous fishes. *Ann. Mag. Nat. Hist.*, ser. 3, 20 (117): 153-167.

A study of poisonous fishes, not venomous ones. It names, as poisonous, fishes in the following genera: *Meletta, Tetraodon, Diodon, Balistes, Caranx, Scarus, Thynnus, Engraulis,* and others. Some case histories are outlined, and typical symptoms are described in detail, with treatment. Causes for toxicity of fish are discussed briefly.

DUNCAN, C.

1951.—A case of toadfish poisoning. *Med. Jour. Australia*, 2 (20): 673-675.

Clinical history and post-mortem are described in a fatal case of poisoning from *Spheroides liosomus*. Some general discussion on fish poisoning is included.

EVERMANN, B. W., and T. H. SHAW.

1927.—Fishes from Eastern China, with descriptions of new species. *Proc. Calif. Acad. Sci.* (4) 16: 122.

Cooking of toadfish, *Sphaeroides ocellatus*, so that it is not poisonous; (not explained).

FLECKER, H.

1946.—Thread finned sea perch, *Lutjanus nematophorus* (Bleeker). Is this fish poisonous? *Fisheries Newsletter* (Cronulla), 5, 4: 18.

No reliable evidence that this fish, also known as Chinaman Fish, is poisonous.

FORSTER, J. R.

1778.—Observations made during a voyage round the world. London: 209-211, 642-649.

A new species of *Tetrodon* [later named *sceleratus*] affected as a powerful poison the three men who ate it. He also mentions a poisonous *Sparus* from Mallicolo and describes symptoms of both forms of poisoning in men and animals.

1844.—Descriptiones Animalium (ed. Lichtenstein), Berlin: 254 and 282.

Poisoning by *Tetrodon sceleratus*.

GILL, W. W.

1876.—Life in the Southern Isles. Religious Tract Society, London, 1876: 274.

Fish poisonous in certain parts of Cook Islands, not in others; poison ascribed to their eating a Nereid worm.

GILMAN, R. L.

1942.—A review of fish poisoning in the Puerto Rico-Virgin Islands area. *U.S. Naval Med. Bull.* 40, 1: 19-27, pls. 5 and 6.

A report of ten cases occurring on Culebra Island.

GRIMBLE, [Sir] A.

1933.—The migrations of a pandanus people. Suppl. *Journ. Polynes. Soc.* (*Memoir* No. 12.) 42, Instalment 1: 17-19.

Poisonous Fishes, Gilbert Islands.

HALSTEAD, B. W.

1951.—Ichthyotoxism, a neglected medical problem. *Med. Arts Sci.*, 5 (4): 115-121, 8 figs.

A general account of the problem of fish poisoning. Clincial characteristics and causes of fish poisoning are discussed.

1954.—A note regarding the toxicity of the fishes of the Skipjack family, Katsuwonidae. *Calif. Fish and Game*, 40: 61-63.

Poisoning from eating *Euthynnus* at Johnston Island and *Katsuwonus* in the Philippines.

HALSTEAD, B. W., and N. C. BUNKER.

1953.—The effect of the commercial canning process upon puffer poison. *Calif. Fish and Game*, 39 (2): 219-228, 4 figs., 1 tab.

A review of chemical studies of the poison. Results of experiments in canning puffers are tabulated, showing that the process affects some species by reducing toxicity. Other species may become completely non-toxic, and in some the poison does not appear to be affected by canning. Clinical characteristics of poisoning are mentioned.

1954.—A survey of the poisonous fishes of the Phoenix Islands. *Copeia*, 1954, 1: 1-11, figs. 1-5.

Collection of material; toxicity tests; public health significance.

HALSTEAD, B. W., and W. M. LIVELY.

1954.—Poisonous fishes and ichthyosarcotoxism. *U.S. Armed Forces Med. Jour.* 5, (2): 157-175, figs. 1-13.

A discussion on the military importance of poisonous fishes. Includes a classification of fish poisoning into four types: puffer poisoning, *Gymnothorax* poisoning, ciguatera, and scombroid poisoning. Case reports for ciguatera are detailed.

HALSTEAD, B. W., and R. J. RALLS.

1954.—Results of dialyzing some fish poisons. *Science*, 119, (3083): 160-161.

Experiments indicate that toxins from four poisonous species (*Fugu, Gymnothorax, Lutjanus,* and *Caranx*) are small water-soluble molecules.

HARRY, R. R.

1953.—Ichthyological Field Data of Raroia Atoll, Tuamotu Archipelago. *Atoll Res. Bull.* 18: 1-190, figs. 1-7.

Poisonous fishes (pp. 71, 117, 167 and 177); venomous fishes (pp. 151, 156 and 177).

HASHIMOTO, Y.

1950.—On the toxicity of a puffer, "nashi-fugu". (Text in Japanese.) *Bull. Jap. Soc. Sci. Fish.*, 16 (2): 43-46, 1 fig., 2 tabs.

Results of experiments on the toxicity of *Sphaeroides vermicularis radiatus* indicate that the ovary and liver are the most poisonous organs, although individual specimens vary greatly in toxicity.

HASHIMOTO, Y., and M. MIGITA.

1951.—Quantitative analysis method for fugu (puffer) toxin. (Text in Japanese.) *Bull. Jap. Soc. Sci. Fish.*, 16 (8): 341-346.

A technical report on experiments with fugu toxin, including details of methods used to extract the poison and a comparison of the dose-effect curve of fugu with shell-fish toxin.

HERRE, A. W.

1924.—Poisonous and worthless fishes. *Philipp. Jour. Sci.* 25, 4: 415-510, pls. 1 and 2; 27, 2, 1925: 167-168.

Taxonomic review of Philippine species likely to be poisonous to eat.

HILL, E. S.

1871.—Sydney Mail (March 4, 1871): 22; (June 3): 426.

Two boys poisoned by toadfishes at Coogee, New South Wales.

1880.—Fishes of and fishing in New South Wales. *Rept. Roy. Comm. Fisheries, New South Wales,* Appendix D, (14): 20-21.

Poisonous fishes, toad fishes, porcupine fishes.

HIROA, TE RANGI.

1938.—Ethnology of Mangareva. *Bernice P. Bish. Mus. Bull.* 157: 301.

Quotes 1856 MS. of Laval on poisonous fishes.

HIYAMA, Y.

1943.—Report on the research of poisonous fish in the South Seas. (Text in Japanese.) *Nissan Fish. Inst.*, Odawara, Japan: 1-137, 29 pls.

Toxicity of many different species is discussed; local names, morphology and distribution of the fishes are included. A large part of the work consists of tables which illustrate the degree of toxicity of various fishes. Experiments on the toxic substances, especially in puffer, are described. Also mentioned are typical symptoms of poisoning, popular theories of the cause of toxicity, and variations in toxicity. A valuable work.

HORA, S. L.

1948.—Knowledge of the ancient Hindus concerning fish and fisheries of India. *Jour. Roy. Asiatic Soc. Bengal,* 14: 7-10.

Method of rendering flesh of fish poisonous to enemies in *ca.* 300 B.C. Parallel modern cases.

INGLETON, G. C.

1952.—True patriots all. Angus & Robertson, Sydney: 88 and 265, 1 fig.

Cases of toadfish poisoning.

ISHIHARA, F.

1918.—Uber die physiologischen Wirkungen des Fugutoxins. *Mitt. Med. Fak. Univ. Tokio,* 20: 375-426, 3 pls.

An excellent and thorough study of the physiological effects of fugutoxin. The reactions of various organ systems and various animals to the toxin are recorded.

1924.—Studien über das Fugutoxin. *Arch. Exp. Path. Pharm.,* 103: 209-218.

An excellent scientific report on the chemical and pharmacological properties of puffer toxin.

JONES, H. W.

1940.—Index-catalogue of the library of the Surgeon-General's office, United States Army. (4) 5: 1006-1012.

Many references to fish poisoning.

JORDAN, D. S.

1929.—Poisonous fishes in Samoa. *Amer. Naturalist,* 63 (687): 382-384.

A report of ten types of fish which may cause poisoning. It lists twelve types which are always edible.

KAEMPFER, E.

1727.—The history of Japan. (English ed.) London, vol. 1: 134, pl. 11, 2 figs.

Toadfish poisoning.

KERGUELEN, Y. J. de.

1772.—Voyage dans l'Inde et aux Terres Australes en 1771-1772. MS. unpublished, in Hydrographic Dept., Paris; copy in Mitchell Library, Sydney: folio 262.

Poisonous toadfish of Western Australia.

KIMURA, S.

1927.—Zur Kenntnis der Wirkung des Tetrodongiftes. *Tohoku Jour. Exp. Med.,* 9: 41-65, 7 figs., 7 tabs.

A fairly complete scientific report of the action of tetrodotoxin in animals. Physiological effects in various experiments were observed and recorded.

KITSON, A.

1907.—Captain James Cook, R.N., F.R.S. "The Circumnavigator", John Murray, London: 289, 298.

Fish poisoning on Cook's Expedition.

LARSEN, N. P.

1942.—Tetrodon poisoning in Hawaii. *Proc. 6th Pac. Sci. Cong. Berkeley*, 5: 417-421.

A review of literature on tetrodon poisoning with a clinical history of three cases in Hawaii. Experiments conducted by the author yielded a white crystal which poisoned laboratory animals. The theory that the poison may come from unusual dietary habits was propounded, since cases of poisoning are rare in Hawaii.

LEE, R. K. C., and H. Q. PANG.

1945.—Ichthyotoxism—fish poisoning. *Amer. Jour. Trop. Med.* 25: 281-285.

This report is concerned with two outbreaks of fish poisoning which occurred in Honolulu following the eating of fishes which had been imported from Midway and Christmas Islands. It also contains a number of case histories and a brief review of the problem of fish poisoning.

LEGROUX, R., D. BOVET, and J. C. LEVADITI.

1947.—Présence d'histamine dans la chair d'un thon responsable d'une intoxication collective. *Ann. Inst. Pasteur*, 73 (1): 101-104.

A report on a series of experiments which showed histamine to be the cause of poisoning from eating tuna. Possible causes for production of histamine are discussed.

LORD, C., and H. H. SCOTT.

1924.—A synopsis of the vertebrate animals of Tasmania. Oldham, Beddome & Meredith, Hobart: 94.

Toadfish poisoning.

McCOY, F.

1867.—On the recent zoology and palaeontology of Victoria. *Offic. Record Intercol. Exhib.* 1866-67: 316.

"Salmon," *Arripis georgianus*, poisoning.

MARKHAM, C.

1904.—The voyages of Pedro Fernandes de Quiroz, 1595 to 1606. Hakluyt Society, London (2), 14-15, vol. 1: 263; vol. 2: 390, 447.

Pargos poisoning members of Quiroz's expedition in the New Hebrides, May 27, 1606.

MARTIN, R. M.

1835.—History of the British colonies. James Cochrane and Co., London, 4: 436-439.

Brief reference is made to three persons being fatally poisoned as a result of eating puffer.

MEREDITH, L. A.

1844.—Notes and sketches of New South Wales. John Murray, London: 155. (Reprinted by: Newman, Edward (1846), *Zoologist*, [4]: 1341.)

Toadfish poisoning [evidently referring to Mrs. Bell's death in Tasmania in 1831].

MOORE, G. F.

1884.—Diary of ten years eventful life of an early settler in Western Australia. M. Walbrook, London: 418.

Aboriginal at Rottnest I. poisoned by eating blow-fish in 1840.

MURRAY, J.

1870.—Poisonous, or moon-struck fish. *Australian Med. Gaz.* (August): 133-135.

Ascribes poisonous qualities to fish having been left in moonlight. Case of poisoning through eating barracouta [evidently "milky" fish whose condition was due to protozoan parasites—G.P.W.].

OGILBY, J. D.

1954.—Commercial Fishes and Fisheries of Queensland. Govt. Printer, Brisbane: 49-53, 102.

Poisoning by Red Bass (*Lutjanus coatesi*); chinaman fish and trigger fishes dangerous to eat.

OMMANEY, H. M.

1834.—MS. report in Public Records Office, London; copy in State archives, Perth, West Australia, August 16, 1834—Quoted by Whitley, 1953: 62.

Death from eating a fish (*? Tetrodon*).

PARADICE, W. E. J.

1926.—Fish and other marine animals of Australia of special interest. *Health Inspect. Assoc. Austr. Quart. Rev.*, 4 (3): 43-48, 2 pls.

Includes notes on various fishes poisonous to eat, or with venomous spines.

PATTISON, G. J.

1872.—Toad fish. *New South Wales Med. Gaz.*, 2 (5): 138-140.

The author presents cases of eating toadfish flesh without ill effects. He has eaten it himself and has fed it to cats and to a dog.

1872.—Fish poisoning. *New South Wales Med. Gaz.*, 2: 145.

Medical treatment is described for five children who were poisoned by eating sardines.

POEY, F.

1866.—Ciguatera. Memoria sobre la enfermedad ocasionada por los Peces venenosos. *Repert. Fisico-Nat. Cuba*, 2 (1): 1-24, and 2 (2): 25-39.

An annotated list of seventy species of fishes suspected of being poisonous in the Caribbean area. Causes of poisoning, symptoms, precautions and curative measures. [Copy in G.P.W. library.]

ROSS, S. G.

1947.—Preliminary report on fish poisoning at Fanning Island (Central Pacific). *Med. Jour. Australia*, 2: 617-621, 3 tabs.

This account involves 95 cases of fish poisoning which occurred at Fanning Island during 1945 to 1947. Author summarizes the clinical characteristics of the outbreak and discusses theories as to the cause of fish poisoning.

SCOTT, J.

1832.—The poisonous or toad fish of Van Diemen's Land. *The Hobart Town Almanack* for the year 1832: 89-90, 1 pl.

Historic account of poisoning of a family in Tasmania [by *Sphaeroides glaber*].

SOMERVILLE, J. D.

1946.—Poisonous fish. *South Australian Naturalist*, 24 (1): 12, 13.

The poisoning of Captain Cook is quoted from G. A. Wood's *The Discovery of Australia.*

SPARRMAN, A.

1944.—A voyage round the world with Captain James Cook in H.M.S. Resolution. Golden Cockerell Press, London: 23, 147 and 167.

Symptoms of redfish and *Tetrodon* poisoning.

SPOFFORTH, J. L.

1887.—A case of poisoning by eating part of a toad-fish. *Australasian Med. Gaz.*, 6: 266.

A brief medical report of symptoms and post-mortem findings in a fatal case of poisoning by a Tetraodon.

STEPHENSON, J.

1838.—Medical zoology and mineralogy. John Churchill, London: 121-128, 3 pls.

An account of symptomatology and other data on poisoning by *Megalops thrissa* (*Clupea*), *Sphyraena barracuda*, *Tetraodon ocellatus*, and *T. sceleratus.*

STEVENS, H. N.

1930.—New light on the discovery of Australia (Journal of Diego de Prado y Tabor). Hakluyt Society, London: 127.

Concerning, the jaundiced fish, pargos, of Quiroz's expedition.

SUEHIRO, Y.

1947.—Practice of fish physiology. Poison of globe fish. (Text in Japanese). Tokyo Imper. Univ.: 140-159.

This includes a review of Japanese work on puffer poison, a list of poisonous fishes, and physiological and chemical studies of the poison. An important work.

1948.—On the physiological function of the puffer-fish poison. (Text in Japanese.) *Suisan Gakkai Ho*, 10 (12): 1-5, 1 tab.

Experiments with pufferfish poison (*Sphaeroides alboplumbeus*) on various animals are tabulated. Some information is included on methods and interpretation of results. A valuable work.

TAHARA, Y.

1910.—Über das Tetrodongift. *Biochem. Zeitschr.*, 30: 255-275.

One of the more important original chemical studies on puffer poison. It includes also some data on physiological effects of the poison.

THOMPSON, L.

1940.—Southern Lau, Fiji: an ethnography. *Bernice P. Bish. Mus. Bull.*, 162: 137.

Fijian fishes poisonous since 1929 hurricane, perhaps due to seaweed.

TITCOMB, M., and M. K. PUKUI.

1951.—Native use of fish in Hawaii. *Journ. Polynes. Soc.* 60: Memoir 29: 30-32.

Fishes poisonous as food.

WAITE, E. R.

1897.—The mammals, reptiles and fishes. *Austr. Mus. Mem.* 3: 182.

Fishes at Funafuti regarded as poisonous when pumice drifted into lagoon.

WHITLEY, G. P.

1932.—The Chinaman fish. *Australian Mus. Mag.*, 4 (11): 394-396, 2 figs.

The varying toxicity of *Paradicichthys venenatus* is discussed, with a taxonomic description and account of its habits.

1934.—A new fish, reputed to be poisonous, from Queensland. *Mem. Queensland Mus.*, 10 (4): 175-179, 1 pl., 1 fig.

A taxonomic description of *Lutjanus coatesi*, which is "reputedly poisonous".

1942.—Poisonous fishes. *Fisheries News Letter* (Cronulla), 1 (5): 5-9.

Toadoes, Chinaman Fish, Red Bass, etc.

1953.—Toadfish poisoning. *Australian Mus. Mag.*, 11 (2): 60-65, 6 figs.

A review of toadfish poisoning in Australia with a warning against any of the species and especially against *Pleuranacanthus sceleratus, P. lunaris, Contusus richei, Ovoides nigropunctatus, Sphaeroides hamiltoni, S. glaber* and *S. pleurogramma.*

1954.—Are Hussars edible? *Australian Mus. Mag.* 11 (6): 194-199, 5 figs.

Various Lutjanidae discussed.

YANO, I.

1937.—The pharmacological study of tetrodotoxin. (Text in Japanese.) *Fukuoka Med. Coll. Jour.*, 30 (9): 1669-1704.

Details are given of experiments with tetrodotoxin on laboratory animals. The author describes the effect of varying doses on vascular and nervous systems. Tetrodotoxin does not produce immunity.

1938.—An experimental study of the globe-fish (fugu) intoxication. *Japanese Jour. Med. Sci.*, 8 (5): 99-101.

A study of the effect of tetrodotoxin on blood-pressure in laboratory animals.

YOKOO, K.

1948.—Chemical study of tetrodotoxin. Report No. 1. (Text in Japanese.) *Riken Iho*, 24 (3): 136-139.

A study on the chemical properties of the poison of *Sphaeroides rubripes.*

1948.—Chemical studies on tetrodotoxin. Report No. 2. (Text in Japanese.) *Hiroshima Igaku* (Hiroshima Medical School), Report 1, No. 2: 52-53.

The first report is thoroughly reviewed, and modified methods of purifying the toxin are described.

1950.—Chemical studies on tetrodotoxin. Report No. 3, Isolation of Spheroidine. (Text in Japanese.) Nihon Kagaku Zasshi, *Japanese Chem. Jour.*; 71 (11): 590-592.

The first two reports are reviewed, and an outline is given of chemical experiments to isolate and study a toxic substance which Yokoo calls Spheroidine. A valuable series of reports.

YUDKIN, W. H.

1944.—Tetrodon poisoning. *Bull. Bingham Oceanogr. Coll.*, 9 (1): 1-18, 1 fig.

A concise scientific treatise on tetrodon poisoning. It briefly reviews history, chemical characteristics of the poison and symptomatology. An important paper.

VENOMOUS FISHES.

AFLALO, F. G.

1896.—A sketch of the natural history of Australia. Macmillan, London: 228, 247.

Fortescue, etc. Brief note.

BANFIELD, E. J.

1908.—The confessions of a beachcomber. Fisher Unwin, London: 143-145, 1 plate.

Popular account of Stonefish.

BAYLEY, H. H.

1940.—Injuries caused by scorpion fish. *Trans. Roy. Soc. Trop. Med. Hyg.*, London, 34 (2): 227-230, 1 pl.

Typical symptoms of scorpion fish wounds are recorded with medical treatment. An incomplete taxonomic description is given for the two species *Scorpaena plumieri* (Bloch) and *S. grandicornis* (Cuv. and Val.).

BOTTARD, A.

1889.—Les Poissons Venimeux. Octave Doin, Paris: 1-198, 34 figs.

A valuable historical review on venomous fishes. The author discussses various types of stinging and biting fishes, describes venom organs, and suggests treatment for wounds from fish. An important work.

BURGESS, J.

1926.—Sting ray injuries. *Med. Jour. Australia*, 2 (14): 465-466.

Clinical characteristics are given for three cases of stingray wounds.

BYRNE, K.

1924.—Injuries and diseases in Australia attributable to animals. *Med. Jour. Australia*, 2: 539.

Synanceja horrida is described as a venomous fish; other animals are mentioned.

CALDWELL, N.

1938.—Titans of the Barrier Reef. Angus & Robertson, Sydney. November: 80-81.

Stings from stingrays.

CASTELLANI, A., and A. J. CHALMERS.

1919.—Manual of tropical medicine. Wm. Wood and Co., New York, ed. 3: 230-241, 4 figs.

Lists the venomous fishes by zoological classification. Examples of each type are given, *e.g.*, *Muraena*, *Synanceja*, *Thalassophryne*, *Trachinus*, and the stingray, with some concise general information.

CLELAND, J. B.

1916.—Injuries and diseases of man in Australia attributable to animals, except those due to snakes and insects (No. 2). *Rept. Direct.-Gen. Public Health New South Wales*, 1915: 266-276.

Injuries from Stingrays and Bullrout; references to toadfish poisoning.

1924.—Injuries and diseases in Australia attributable to animals (except insects). *Med. Jour. Australia*, 11 (2): 339-345.

Shark-bites, numb-fish, catfish, fortescue, stingrays, *Kathetostoma*, black trevalli, toadfish.

1942.—Injuries from animals. *Med. Jour. Australia*, 2 (22): 490-491.

Two cases of injury are described: one from eating mussels and one from being stung by a catfish. Treatment of the catfish sting is reported.

COOK, H.

1950.—Venomous marine animals in Australian waters. *Illustrated London News*, (4th March): 340, 3 figs.

An interesting popular account on the Australian venomous stonefish, scorpionfish and stingrays.

DANE, P. G.

1926.—Sting ray injuries. *Med. Jour. Australia*, 2 (20): 677.

This note describes treatment given for a stingray injury.

DUHIG, J. V.

1929.—The nature of the venom of *Synanceja horrida* (the stonefish). *Zschr. Immunforsch.*, 62 (3-4): 185-189, 2 figs.

An account of the experiments used to determine the nature of *Synanceja horrida* venom.

DUHIG, J. V., and G. JONES.

1928.—The venom apparatus of the stonefish (*Synanceja horrida*). *Mem. Queensland Mus.*, 9 (2): 136-150, 8 figs.

An important report on the anatomy of the venom organ of *Synanceja horrida*. Clinical notes on a case of wounding by stonefish are supplied by M. J. Gallagher.

1928.—Haemotoxin of the venom of *Synanceja horrida*. *Australian Jour. Exp. Biol.*, (2): 173-179, 6 tabs.

A report on the haemotoxic properties of stonefish venom. Quantitative experiments were made with the venom on guinea-pig, sheep and human red blood cells. The venom is said to have physiological properties similar to cobra venom and curare.

EVANS, H. M.

1916.—The poison-organ of the sting-ray (*Trygon pastinaca*). *Proc. Zool. Soc. London*, 29 (1): 431-440, 7 figs.

A report on the histology of the sting and venom gland of the stingray, *Trygon*. It presents evidence that the secretion is actually a venom. A very important paper on the subject.

1920.—The poison of the spiny dog-fish. *Brit. Med. Jour.*, 1 (3087): 287-288, 5 figs.

A discussion on the histology of the spine of *Acanthias vulgaris*, with mention of a person who was wounded by a dogfish spine.

1921.—The poison organs and venoms of venomous fish. *Brit. Med. Jour.*, 2 (3174): 690-692, 2 figs.

A general summary of information about *Trygon*, *Trachinus*, and *Scorpaena*, from Aristotle to modern times. It gives briefly the anatomical location of the venom glands in the spines of *Scorpaena*, *Synanceia*, and *Thalassophryne*. Several experiments were performed to show the effects of this venom on fish and laboratory animals. Treatment for wounds is discussed.

1923.—The defensive spines of fishes, living and fossil, and the glandular structure in connection therewith, with observations on the nature of fish venoms. *Philos. Trans. Roy. Soc. London*, ser. B, 212: 1-33, 3 pls., 14 figs.

A valuable histological study of the venom organs of some venomous fishes (*Trygon pastinaca*, *Acanthias vulgaris*, *Cestracion philippi* and *Chimaera monstrosa*). Experiments with *Trachinus draco* venom are described.

1924.—The poison gland of Trygon—supplementary note. *Proc. Roy. Soc. London*, ser. B, 96: 491-493, 2 figs.

Additional histological experiments confirm the presence of a venom gland in a stingray (*Trygon*).

1943.—Sting-fish and seafarer. Faber and Faber, London: 1-180.

This book discusses weevers (*Trachinus*), other stingfish, stingrays, scorpionfish, *Muraena*, other eels, surgeonfish, triggerfish, catfish, electric fish, jellyfish, and others. Scientific names are given wherever possible, and histological descriptions of the venom organs appear often. The book is written in a popular style but contains a great deal of valuable information.

1944.—Sharks: vicious and venomous. *Lancet*, (2) 247 (6331): 859-860.

Listed as venomous sharks are the spiny dogfish, the Port Jackson shark and the chimaeras. They are said to have venom glands connected with their spines. The article is of minor importance.

1945.—Toxic properties of sting-ray's sting. *Brit. Med. Jour.*, 4413: 165.

Clinical notes on cases of stingray wound in the Bay of Bengal are given. Effects of stingings from the stingray and from jellyfish are compared.

FROES, H. P.

1933.—Studies on venomous fishes of tropical countries. *Jour. Trop. Med. Hyg.*, 36: 134-135, 2 figs.

A brief report on experimental work showing that the venom of *Thalassophryne* acts as a neurotoxin.

GILL, W. W.

1874.—Natural history anecdotes, Poisonous fish. *Sydney Morning Herald* (January 8): 3; *Sydney Mail* (January 10): 50.

Crab, nereid, fish and cone-shell, Hervey Islands.

1888.—Zoologische Miszellan aus der Südsee. *Mitteil. Geogr. Ges. Thuringen*, Jena, 7: 18-37.

Especially pp. 22-24, stingrays, and 24-25 stonefish.

GUDGER, E. W.

1943.—Is the stingray's sting poisonous? *Bull. Hist. Med.*, 14 (4): 467-504, 12 figs.

An excellent historical résumé of the venomous properties of stings of stingrays. An important historical work.

1947.—Is the stingray's sting poisonous to vertebrates other than men and fishes? *Amer. Naturalist*, 81: 297-307, 4 figs.

This paper is essentially a review of the work of J. Vellard (1931) which showed that vertebrates other than man are affected by the venom of stingrays.

HALSTEAD, B. W., and N. C. BUNKER.

1952.—The venom apparatus of the ratfish *Hydrolagus colliei*. *Copeia*, (3): 128-138, 1 pl., 4 figs., 3 tabs.

A detailed report on the gross and microscopic anatomy of *Hydrolagus colliei*.

1953.—Stingray attacks and their treatment. *Amer. Jour. Trop. Med. Hyg.*, 2 (1): 115-128, 12 figs.

A general résumé of the anatomy of stingrays as it relates to their stinging ability. Clinical characteristics and treatment of stingray attacks are discussed.

HALSTEAD, B. W., L. S. KUNINOBU and H. B. HEBARD.

1953.—Catfish stings and the venom apparatus of the Mexican catfish, *Galeichthys felis* (Linnaeus). *Trans. Amer. Micr. Soc.*, 72 (4): 297-314, 6 figs.

An exhaustive study on catfish stings and the anatomy of the venom organs of catfishes.

HALSTEAD, B. W., and F. R. MODGLIN.

1950.—A preliminary report on the venom apparatus of the bat-ray, *Holorhinus californicus*. *Copeia*, (3): 165-175, 6 figs.

A study of the gross and microscopic anatomy of the venom organ of *Holorhinus californicus*.

HARMON, R. W., and C. B. POLLARD.

1948.—Bibliography of animal venoms. University of Florida Press, Gainesville, Florida: 1-340.

A chronological bibliography covering the years 1875 to 1946. References to venomous fishes are scattered throughout. A valuable work.

HEWITT, G. H.

1943.—The treatment of bullrout lesions. *Med. Jour. Australia*, 2 (December 11): 491-492.

Treatment with novocain.

HOLLOWAY, J. E., N. C. BUNKER and B. W. HALSTEAD.

1953.—The venom of *Urobatis halleri* (Cooper), the round stingray. *Calif. Fish and Game*, 39 (1): 77-82, 1 fig., 2 tabs.

The venom of the round stingray is found to be concentrated in the epithelium lining the ventrolateral-glandular grooves of the sting. Experiments indicating this are described and results tabulated.

JORG, M. E.

1939.—Ulcera cutánea gangrenosa por herida com espina caudal de pez raya. (Histologia del apéndice caudal de *Potamotrygon* sp.) *Novena Reunión Sec. Argent. Patol. Reg.*, 3:1599-1616, 11 figs.—*fide Zool. Record* 1940 (1941), Pisces, p. 11.

KESTEVEN, L.

1914.—The venom of the fish *Notesthes robusta*. *Proc. Linnean Soc. New South Wales*, 39 (1): 91-92.

A report on the clinical characteristics of a wound from *Notesthes robusta*, the bullrout. The author concludes that the sting is undoubtedly venomous.

LABILLARDIÈRE, J. J.

1800.—Voyage in search of La Perouse. (English ed.) 2: 253.

Seaman pricked by *Scorpaena digitata* in New Caledonia.

LIGGINS, J. B.

1939.—An unusual bathing fatality. *New Zealand Med. Jour.*, 38: 27-29.

A clinical report of the internal and external injuries to a girl whose heart was pierced by a stingray's sting.

McCulloch, A. R.

1925.—Stone fishes and the art of camouflage. *Australian Mus. Mag.*, 2: 159-162, 3 figs.

Popular article

Mylrea, C. S. G.

1923-24.—A note on the treatment of scorpion sting and the sting of venomous fishes in Arabia. *Trans. Roy. Soc. Trop. Med. Hyg.*, 17: 210-211.

The author advocates novocaine and adrenalin for the sting of scorpions and venomous fishes.

Ocampo, R. R., B. W. Halstead and F. R. Modglin.

1953.—The microscopic anatomy of the caudal appendage of the spotted eagleray, *Aetobatus narinari* (Euphrasen), with special reference to the venom apparatus. *Anat. Rec.*, 115 (1): 87-99, 9 figs.

A detailed histological study of the caudal appendage and venom apparatus of the stingray *Aetobatus narinari*. Recommendations are made regarding the terminology concerned with the anatomy of stingray venom organs.

Ogilby, J. D.

1893.—Edible fishes and crustaceans of New South Wales. Govt. Printer, Sydney: 68.

Bullrout sting.

1903.—Studies in the ichthyology of Queensland. *Proc. Roy. Soc. Queensland*, 18: 7-27.

A taxonomic report on the genus *Centropogon*. The author is of the opinion that *Notesthes robusta* is not venomous.

Paradice, W. E. J.

1924.—Injuries and lesions caused by the bites of animals and insects. *Med. Jour. Australia*: 650-652, 2 figs.

Brief reports are made of the following cases: bites by eels, Chinaman fish poisoning, pricks from worms and gill rakers of fish, stabs from the spine of *Squalus megalops*, stings from sea urchins and from *Plotosus megastomus* and from *Urolophus testaceous*, poisoning from *Tetrodon*, rash from larval ticks, cuts from coral, and burning from jellyfish slime in the eye.

Pawlowsky, E. N.

1907.—On the anatomy of the epidermis and its glands in venomous fish. (Text in Russian.) *Trav. Soc. Imp. Natur. St. Petersbourg*, 38 (1): 265-282.

A histological study of the epidermis and skin glands in venomous fish. Species of the following genera were studied: *Trachinus, Scorpaena, Batrachus, Doras, Trygon*, and *Lepadogaster*.

1909.—On the question of the (poisonous) skin glands of certain fishes. (Text in Russian.) *Trav. Soc. Imp. Natur. St. Petersbourg*, 40 (1): 109-126, 5 figs.

This article appeared in German as follows:

1909.—Ein Beitrag zur Kenntniss der Hautdrüsen (Giftdrüsen) einiger Fische. *Anat. Anz.*, 34 (13-14): 314-330, 6 figs.

A histological study of the skin glands (and venom apparatus) of such venomous fish as *Sebastes, Pelor, Acanthurus, Blepsias* (Cottidae), and *Muraena*. Reference is also made to studies on *Scorpaena, Trachinus, Trygon, Pterois*, and others.

1911.—On the question of the structure of the poison glands of some fishes of the family Scorpaenidae. (Text in Russian.) *Trav. Soc. Imp. Natur. St. Petersbourg*, 41 (1): 317-328.

This article appeared in German as follows:

1911.—Ein Beitrag zur Kenntniss des Baues der Giftdrüsen einiger Scorpaeniden. *Zool. Jahrb.*, 31: 529-542.

A histological study of the venom glands of *Synanceia erosa, Pterois lunulata*, and *Scorpaena fimbriata*. Other venomous fishes which have been studied are named, and some general information is included.

1914.—Über den Bau der Giftdrüsen bei *Plotosus* und anderen Fischen. *Zool. Jahrb.*, 38: 427-442, 3 pls., 4 figs.

A detailed discussion of the histology of the venom organs of *Apistus, Paracentropogon, Pterois, Siganus*, and *Plotosus*.

Phisalix, M.

1931.—Le venin de quelques poissons marins. *Notes*, Station Océanogr. Salammbô, No. 22: 3-15.

A report on the toxicity of the venom of *Trachinus draco, Scorpaena porcus, Trygon pastinaca*, the bite of *Muraena helena*, and the serum of *M. helena*. Venom apparatus of each is anatomically described and experimental data are included.

RALPH, C. C.

1943.—Poison of the stone-fish. *Vict. Naturalist*, 60: 77.

New Guinea stonefish venom.

REED, H. D.

1907.—The poison glands of *Noturus* and *Schilbeodes*. *Amer. Naturalist*, 41: 553-566, 5 figs.

A detailed histological study on the venom apparatus of *Noturus* and *Schilbeodes*. An important anatomical work.

1924.—The morphology of the dermal glands in Nematognathous fishes. *Zschr. Morph. Anthrop.*, 24: 227-264, 32 figs.

A report on the dermal glands of catfishes with reference to their venom organs. An important paper.

RONKA, E. K., and W. F. ROE.

1945.—Cardiac wound caused by the spine of the stingray (suborder Masticura). *Mil. Surg.*, 97: 135-137.

A clinical report on a victim who received a cardiac puncture from a stingray.

RUSSELL, F. E.

1953.—Stingray injuries: a review and discussion of their treatment. *Amer. Journ. Med. Sci.*, 226: 611-622, figs. 1-3.

1954.—The Stingray. *Engineering & Science Monthly*. Pasadena, Calif. January: 15-18, 6 figs.

Many "attacks" in California and other countries, including Australia. Effects of venom.

SACCHI, M.

1895.—Sulla struttura degli organi del veleno della Scorpena. *Boll. Mus. Zool.*, Genova, (30): 1-10; (36): 1-4, 1 pl.

Excellent descriptions of the venom organs of *Scorpaena*.

SAVILLE-KENT, W.

1893.—The Great Barrier Reef of Australia. Allen and Co., London: 286, pl. 47, fig. 1.

Brief reference is made to the venomous properties of the stonefish.

SCHNEE, S.

1908.—Vorläufige Mitteilungen über eine beobachtete Vergiftung durch den Feuerfisch (*Pterois*). *Arch. Schiffs. Tropenhyg.*, 12: 166-167.

A report on the treatment for a wound from *Pterois*, with comments on the appearance of the fish. The paper is of minor importance.

SMITH, J. L. B.

1951.—A case of poisoning by the stonefish, *Synanceja verrucosa*. *Copeia*, (3): 207-210.

Personal experience of a wound from *Synanceja verrucosa* is related. An excellent case report.

TASCHENBERG, E. O.

1909.—Die giftigen Tiere. Stuttgart: 174-194 (figs. 34-41), 253-267 (figs. 60-62), and 293-297.

A fairly complete record is made of poisonous and venomous fishes, with comments on the habitat, appearance and toxic effects of many.

VELLARD, J.

1931.—Venin des raies (*Taeniura*) du Rio Araguaya (Brésil). *Compt. rend. Acad. Sci.*, Paris, 192: 1279-1281.

Experiments are described to show the physiological reactions of various animals to the venom of *Taeniura dumerilii* and *T. mülleri*. An important paper.

WALLACE, L. B.

1893.—The structure and development of the axillary gland of *Batrachus*. *Jour. Morph.*, 8: 563-568, 1 pl.

Histological study of *Batrachus* glands as described, showed three sets of glands near the pectoral fin. The nature of the secretion was not determined.

WHITLEY, G. P.

1932.—Fishes. Great Barrier Reef Exped. 1928-29, Sci. Rept., 4 (9): 306-310, pl. 4, figs. 1-2.

A taxonomic description of *Synanceja trachynis* with a reference to the venom organ.

1943.—Venomous fishes. Fisheries News Letter, 2 (1): 7-8.

Popular account.

WHITLEY, G. P., and W. BOARDMAN.

1929.—Quaint Creatures of a Coral Isle. *Australian Mus. Mag.*, 3 (11): 366-374, 13 figs.

Synanceja horrida is mentioned as being deadly. A case of poisoning from one of its spines is included.

WRIGHT-SMITH, R. J.

1945.—A case of fatal stabbing by a stingray. *Med. Jour. Australia*, 2: 466-467, 2 figs.

A clinical account of a fatal stingray attack, including autopsy report and general data about stingrays.

WUTH, E. M.

1877.—On fish-poison. *Australian Med. Jour.*, 22: 273-276.

A medical account of a wound received from a stingray and the author's treatment for it. Some general observations are also made on jellyfish and mussel poisoning.

ZAHN, C.

1943.—The Rattlesnake of the Sea. *Natural History* (New York), 51, 2. February: 100-101.

Stingray, *Urobatis halleri*.

ADDENDA

As this Bibliography was in the course of publication the following papers were received in Sydney: the first two dealing with poisonous fishes, and the third with venomous fishes.

CLARK, E., and H. A. F. GOHAR.

1953.—The fishes of the Red Sea: Order Plectognathi. *Publ. Mar. Biol. Stat. Al Ghardaqa* (Red Sea), 8: 1-80, pls. 1-5.

Poisonous properties of blowfishes and method of preparing them for food. Regional variation in poison of *Lagocephalus sceleratus* with fatal cases of poisoning at Giemsa, Red Sea.

HALSTEAD, B. W., and N. C. BUNKER.

1954.—A survey of the poisonous fishes of Johnston Island. *Zoologica* 39, 2: 61-77, fig. 1 (map).

Extracts of various parts of 206 fishes, representing 60 species, tested on white mice. About 75 per cent. were found to be toxic: 64 per cent. of those tested had toxic musculature and about 98 per cent. of the poisonous fishes had toxic viscera.

RUSSELL, F. E., and A. VAN HARREFELD.

1954.—Cardiovascular effects of the venom of the Round Stingray, *Urobatis halleri*. *Arch. internat. Physiol.*, 62: 322-333, figs. 1-6.

Observations on vasodilatation and vasoconstriction. The venom has a direct effect on the heart.

GRAPTOLITE LOCALITIES OF THE SNOWY MOUNTAINS, NEW SOUTH WALES

By H. O. Fletcher.

(Graptolite Identifications by Mrs. K. Sherrard, M.Sc.)

(4 Maps.)

The initiation of the Snowy Mountains Hydro-Electric Authority gave a decided impetus to geological research over an area of some 6,000 square miles in southern New South Wales.

Following the Authority's request in 1949 for geologic investigation, officers of the Geological Survey of New South Wales have mapped more than 3,000 square miles of this country by detailed reconnaissance standard on a scale of 1 inch = 1 mile. During the course of these surveys an itensive search was made for fossil remains.

The information embodied in this report was gained during several visits to the Snowy Mountains with Survey parties in the author's capacity as Honorary Palaeontologist to the Geological Survey of New South Wales. A good deal of the information is included in the Snowy Mountains Reports (unpublished) of the Department of Mines. I am indebted to Mrs. Kathleen Sherrard for the graptolite identifications.

Previously the geology of the Snowy Mountains area was not very well known except for a broad generalization. The age of the meta-sediments, which comprise a large section of the region, was matter of considerable doubt.

The first graptolite remains to be recorded from the actual Snowy Mountains area are those mentioned by David (1908, p. 659), from Barney's Range, near Berridale. The genus *Leptograptus* was recognized among the specimens.

Laseron (1909, p. 118) recorded graptolites from a black slate at Wambrook Creek, which crosses the Adaminaby Road, eleven miles from Cooma. Specimens were collected from some distance up the creek on the southern side of the road. Laseron's locality was again mentioned by Browne (1914, p. 191), and the following list of graptolites, supplied by Laseron, was published: *Diplograptus foliaceus* (very abundant), *Climacograptus bicornis, C. hastata* (very abundant), *Dicellograptus elegans, D. caduceus, D. affinis,* ? *Pleurograptus.*

Öpik (1952, p. 1), recognized at Wambrook Creek, *Pleurograptus linearis,* the zone species of the lower zone of the Bolindian, and also *Dicranograptus nicholsoni* indicating the top of the lower zone of the Eastonian ("zone with *Climacograptus wilsoni*"). In between, as Öpik points out, "is the complete Upper Eastonian zone with *Dicranograptus clingani* = *D. hians.*"

Poorly preserved graptolites and apparently only recognizable as such have been recorded from black shales exposed at McCarty's Crossing, near the junction of Bridle Creek and the Murrumbidgee River. The locality is about four miles to the north-north-east of the Wambrook Creek locality.

A further locality is mentioned by Browne (1914, p. 192), at Geygedzerick Hill, 2½ miles north-east of Berridale. The slates at this locality although greatly altered contain an abundance of well preserved graptolites, said to include *Diplograptus, Didymograptus* and *Tetragraptus.*

Graptolites of Upper Ordovician age were also recorded by Mulholland (1937, p. 124) from black slates at Sheep Station Creek, near Beloka Station, and in Beloka Creek (Portion 73, Parish Wilson, County Wallace).

Other known graptolite localities do not fall within the area of the Snowy Mountains and are not mentioned. These would include those recorded by Carne (1897, p. 153) and found during a survey of the border country between New South Wales and Victoria, and the locality recently discovered by Keble between Jingellic and Tumbarumba.

During the past three years a number of graptolite localities have been visited by members of the Geological Survey of New South Wales and the Australian Museum. These localities fall broadly into several geographic groups as follows:—

(1) The Wambrook Occurrence, 10 miles west of Cooma.

(2) The Caddigat Occurrence, 20 miles north-west of Cooma.

(3) The Tumut Pond Occurrence, about 12 miles south-west of Kiandra.

(4) The Eastbourne Occurrence, on the Eucumbene River, 10-15 miles south of Adaminaby.

(5) The Geehi Occurrence, on the upper reaches of the Geehi River, a major tributary of the Murray River.

Apart from these defined groups several isolated occurrences are found, the most notable being one near Wullwye Trigonometrical Station, five miles east-north-east of Dalgety. Another on the Snowy River is found five miles west of Dalgety.

The wide geographic distribution of these graptolite localities suggests that all the metamorphic rocks between Cooma and Khancoban are of Upper Ordovician age.

The Wambrook Occurrence. (Sketch Map 1.)

Locality 1.—Portion 42, Parish of Lake, County Wallace, approximately 1 mile next south of bridge on Monaro Highway over Wambrook Creek.

The graptolites occur on top of a ridge in a greyish altered slate with a distinct bedding cleavage. Mineral solutions have partly obscured and stained the graptolite remains a reddish-brown colour.

The following species are represented: *Dicranograptus ramosus, Diplograptus* sp., *Climacograptus caudatus, Diplograptus* cf. *apiculatus, Diplograptus apiculatus, ? Climacograptus minimus, Dicellograptus* sp.

Specimens F.43890—F.43935, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria.)

Locality 2.—Portion 111, Parish Coolringdon, County Beresford. One mile west-north-west of Coolringdon Trig. Station and 1 mile south of the Monaro Highway.

The graptolites at this locality occur in a light grey to white slate (strongly leached) in a creek near the middle of the eastern boundary of the portion. Specimens stained by iron oxide.

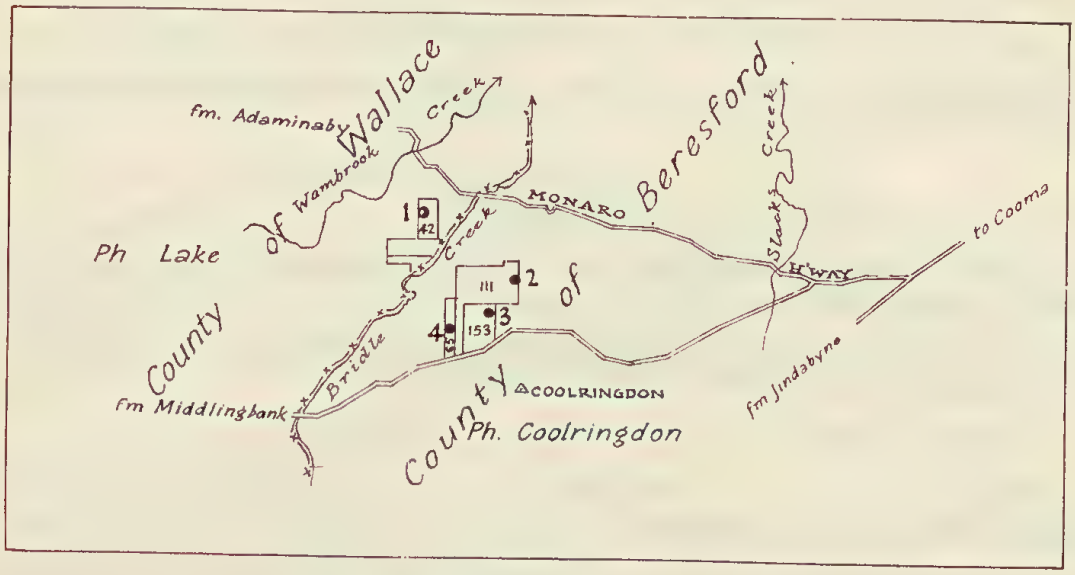
The following species have been recognized: *Cryptograptus tricornis, Diplograptus apiculatus, Climacograptus caudatus, Climacograptus tubuliferus, Diplograptus* sp., ? *Leptograptus flaccidus* var. *macer.*

Specimens F.43826—F.43844, F.43878—F.43887, F.43939—F.43943, Australian Museum Collection.

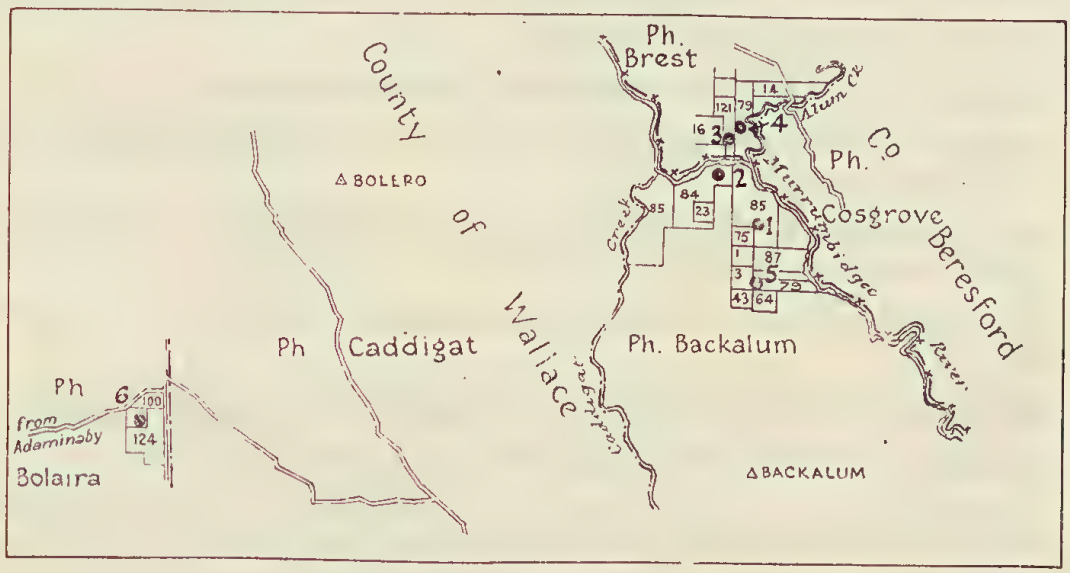
Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria).

Locality 3.—Portion 153, Parish of Coolringdon, County Beresford.

The graptolites from this locality are not well preserved. They occur in a dark-grey altered slate and are stained red by mineral solutions.



Sketch Map 1
WAMBROOK



Sketch Map 2
CADDIGAT

The following species are represented: ? *Climacograptus* sp; ? *Diplograptus* sp.

Specimens F.43936—F.43938, Australian Museum Collection.

Geological Age.—Not determined.

Locality 4.—Portion 65, Parish Coolringdon, County Beresford. One mile north-west of Coolringdon Trig. Station, north of Middlebank Road and about in the centre of the portion.

The graptolites occur in a highly altered chiastolite-bearing black slate. The specimens are not well preserved and are deeply stained with iron oxide.

The following species are represented: *Dicellograptus* cf. *morrisi, Diplograptus apiculatus.* Many indeterminate specimens.

Specimens F.43759—F.43773, F.43819—F.43825, F.43950—F.43952.

Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria.)

The Caddigat Occurrence. (See Sketch Map 2.)

Locality 1.—Centre of C.P.L. 85, Parish Backalum, County Wallace, about 3½ miles north of Backalum Trig. Station.

The following species are represented: *Dicellograptus caduceus, Diplograptus* sp., *Dicellograptus morrisi, Dicellograptus* cf. *elegans.*

Specimens F.44307—F.44310, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria.)

Locality 2.—North-east corner of Portion 84, Parish Backalum, County Wallace, about 3½ miles north of Backalum Trigonometrical Station.

The following species are represented: *Climacograptus* sp., *Climacograptus caudatus, Dicranograptus ramosus, Diplograptus calcaratus, Climacograptus bicornis, Diplograptus* sp., *Climacograptus minimus.*

Specimens F.44284—F.44296, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria.)

Locality 3.—Portion 121, Parish Brest, County Beresford. Graptolites are found in the south-central part of the portion.

The following species were recorded: *Climacograptus caudatus, Climacograptus* or *Diplograptus.*

Specimens F.44302—F.44306, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone not certain.

Locality 4.—Portion 79, Parish Brest, County Beresford. Graptolites are found on the crest of a ridge near a fence and the locality is a few chains north-north-east from locality 3.

The following graptolites are represented: *Diplograptus* sp., cf. *Climacograptus caudatus.*

Geological Age.—Upper Ordovician. Zone uncertain.

Locality 5.—Portion 64, Parish Backalum, County Wallace. Graptolites are found in the north-west corner of the portion and the locality is about 2¼ miles north of the Backalum Trigonometrical Station.

The following species is represented: *Diplograptus* sp.

Specimen F.44297, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone uncertain.

Localities 1–5 are close to the Murrumbidgee River and about 13 to 14 miles east of the township of Adaminaby.

Locality 6.—Portion 87, Parish Bolaira, County Wallace. Graptolites are found in a small quarry one-quarter of a mile south of Dry Plain Road, about 4½ miles east of Adaminaby.

The following species are represented: *Diplograptus* sp., *Diplograptus calcaratus* var. *vulgatus.*

Specimens F.44298—F.44301, Australian Museum Collection.

The graptolites from this locality are not well preserved and many were indeterminate. Mrs. Sherrard remarks: "The slate from this locality has been subjected to contact metamorphism and there is a considerable development of chiastolite. The graptolites are preserved as a very tenuous film of iron sulphide. However, these long, wide diplograptid-like forms are characteristic of the Upper Ordovician, zones 11 and 12".

The Tumut Pond Occurrence.

Several visits were made to the Tumut Pond area by members of the Geological Survey of New South Wales during their work in the region but the search for graptolites or other fossil remains was unsuccessful.

Dr. Öpik (1952, p. 2) of the Bureau of Mineral Resources, Canberra, has reported the occurrence of rare ostracods, fragments of small brachiopods and several graptolites from the black shale east of Tumut Pond. The graptolites recorded are *Orthograptus* near to *O. quadrimucronatus,* fragments of a *Cryptograptus,* a *Climacograptus,* most probably *C. scharenbergi,* and *Dicellograptus divaricatus* cf. var. *salopiensis.* These graptolites, as pointed out by Dr. Öpik, indicate the Gisbornian, Lower Upper Ordovician.

Recently Mrs. K. Sherrard visited the Tumut Pond area and secured a collection of graptolites. The results of her investigations are yet to be published.

The Eastbourne Occurrence. (See Sketch Map 3.)

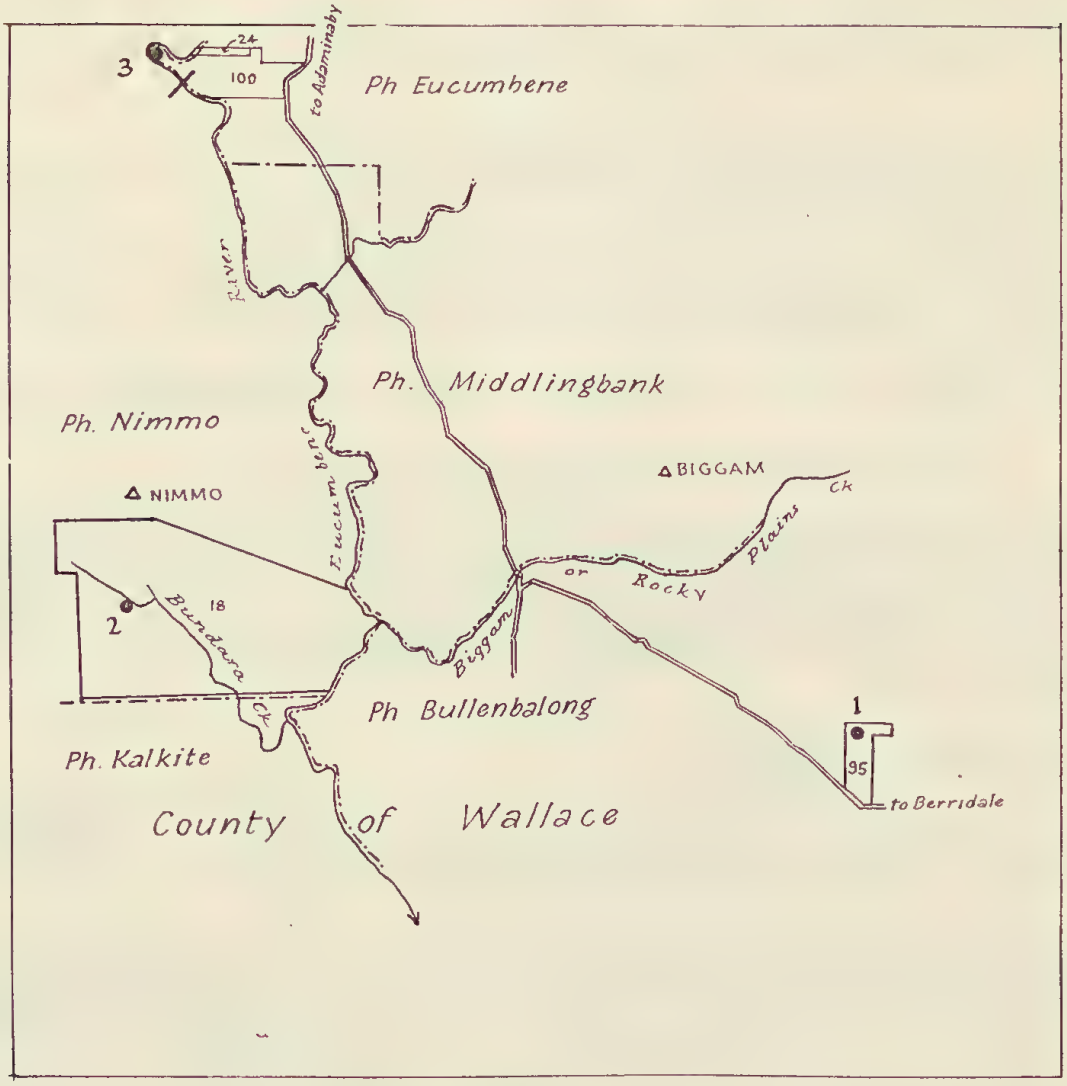
Locality 1.—Portion 95, Parish Bullenbalong, County Wallace, 8 miles northwest of Berridale on the Rocky Plain Road. The graptolites are found on top of a small wooded hill to the north of the road. They occur in an unaltered black slate with the impressions white in colour.

The following species are represented: *Diplograptus* sp., *Climacograptus tridentatus, Climacograptus bicornis, Dicranograptus nicholsoni.*

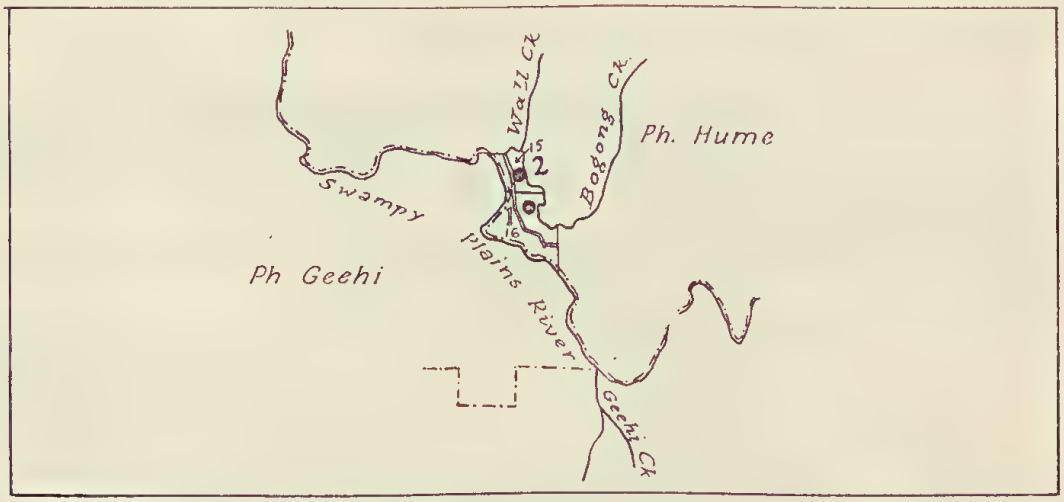
Specimens F.43743—F.43758, F.43774—F.43819, Australian Museum Collection.

Geological Age.—Upper Ordovician. (Zone of *Dicranograptus wilsoni*), lower horizon of Eastonian in Victoria.

Locality 2.—Portion 18, Parish of Nimmo, County Wallace. Near the headwaters of Bundara Creek, an east-flowing tributary of the Eucumbene River.



Sketch Map 3.
EAST BOURNE



Sketch Map 4
GEEHI

The graptolites from this locality were found in a very small isolated patch in an extensive outcrop of very altered slate. The outcrop is close to the contact with granite. None of the specimens could be identified but Mrs. Sherrard has no doubt regarding their Upper Ordovician age.

The graptolite material collected from this locality has been registered in the Australian Museum Collection, numbers F.43845—F.43878.

Locality 3.—Portion 100, Parish Eucumbene, County Wallace. The graptolites are found ½ mile upstream from the Eagle Hawk Adaminaby Dam Site.

The following graptolites are represented: ? *Glossograptus hincksii,* form of *Diplograptus calcaratus* but species uncertain, ? *Climacograptus* sp. possibly *C. minimus,* ? *Lasiograptus* type, *Diplograptus* sp.

Mrs. Sherrard reports that "though all the graptolites from this locality are poorly preserved and all fragmentary, and the rock metamorphosed, the fact that fragments seen on twenty or more specimens are of Diplograptids, fairly large and wide and occasionally showing traces of a wide virgular tube, seems evidence enough to point to one of three zones of the Upper Ordovician, either Zones 10, 11 or 12, somewhere above, below or at the base of the Eastonian of Victoria. These are the zones characterized by large Diplograptids".

Further graptolites from the Adaminaby Dam Site appearing as indistinct impressions on a chiastolite slate are as follows: *Climacograptus caudatus* or *Cl. tubuliferus, Dicellograptus* cf. *pumilis, Climacograptus* sp., *Diplograptus* sp., *Climacograptus caudatus, Dicellograptus* may be *D. elegans;* indeterminate remains.

Specimens F.45229—F.45235, Australian Museum Collection.

Geological Age.—High Upper Ordovician.

THE GEEHI OCCURRENCE. (See Sketch Map No. 4.)

An extensive series of sedimentary rocks on the western flanks of the Snowy Mountains and in the areas drained by the Geehi and Murray Rivers was closely examined for fossil remains during a visit to the area in November, 1951, by the author, with Messrs. L. R. Hall and D. Wynn of the Geological Survey of New South Wales. Graptolites were found for the first time at two localities.

The sediments extend over a large area of country and consist mainly of highly altered and silicified slates with occasional interbedded quartzites. The slates on occasions pass into schists and phyllites.

The areas visited included Swampy Plain Creek where the highly silicified and sheared slates and quartzites appear to be totally devoid of any fossil remains.

The Snowy Mountains Hydro-Electric Authority has recently had constructed a road from Khancoban to Tom Groggin on the Murray River. Road cuttings have exposed the sediments to a considerable extent but a careful search resulted in graptolites being found only on two occasions. Granite is traversed from Khancoban almost to the Geehi Walls where just before the steep descent a contact is found between it and the sediments. These sediments, which then continue almost to the mouth of the Geehi Creek, are dominantly slates and phyllites with minor developments of interbedded quartzites and schists. The slates are frequently perfectly laminated.

An occurrence of graptolites was found near the side of the road on a ridge between Bogong Creek and the Geehi River. The slates are strongly leached at this locality and fairly rich in graptolites although they are restricted to a comparatively narrow zone. The white-coloured graptolite-bearing slates have a north-south strike and are dipping vertically. Graptolite remains are for the most part well preserved and are revealed as pale mauve coloured impressions.

Locality 1.—Portion 16, Parish Hume, County Selwyn. The following species are represented: *Dicellograptus elegans, Dicellograptus* cf. *morrisi, Climacograptus* sp., *Diplograptus calcaratus* var. *basilicus, Dicellograptus* sp., *Dicellograptus* cf. *pumilis, Diplograptus* sp., ? *Dicellograptus* cf. *forchammeri;* indeterminate remains.

Specimens F.44508—F.44555, Australian Museum Collection.

Locality 2.—Portion 15, Parish Hume, County Selwyn.

This locality is about one quarter of a mile below (N.N.W. of) the above occurrence. The graptolites are exposed in a road cutting of the new road, at the time in the process of being completed, and occur in a leached slate which is almost certainly on the same horizon as the slates from the first locality.

The following species are represented: *Dicellograptus morrisi, Dicellograptus* cf. *forchammeri, Diplograptus calcaratus* var. *basilicus, Diplograptus* cf. *quadrimucronatus.*

Specimens F.44556—F.44571, Australian Museum Collection.

Geological Age.—In the opinion of Mrs. Sherrard the graptolites from Locality 2 are almost certainly from the zone of *Pleurograptus linearis,* that is Zone 14 of the British Succession, and the equivalent of the Bolindian of Victoria, Upper Ordovician. The graptolite evidence from Locality 1, indicates a possibility of the same horizon. Field-work also suggests that both the graptolite horizons belong to the same zone.

The occurrence of graptolites in the sediments west of the main range of Kosciusko is of importance as they are the first to be recorded from that area in New South Wales. It is also the first time that Upper Ordovician sediments of Bolindian age have been recognized in New South Wales. Upper Ordovician graptolites have been recorded from the Corryong district, Victoria, in rocks lithologically similar to the Geehi sediments.

Isolated Localities.

A locality on the right bank of the Snowy River. Northern part of Portion 113, Parish Beloka, County Wallace.

The following species are represented: *Dicellograptus* cf. *pumilis, Diplograptus* possibly *D. calcaratus* var. *vulgatus,* ? *Glossograptus hincksii, Climacograptus, Diplograptus* possibly *D. quadrimucronatus, Dicellograptus* cf. *elegans, Diplograptus* sp., *Dicellograptus pumilis, Diplograptus calcaratus* var.

Specimens F.44479—F.44487, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria).

As mentioned earlier, Upper Ordovician graptolites have been collected from Sheep Station Creek and Beloka Creek; both these localities are only a few miles south of Portion 113.

A locality half a mile south of Wullwye Trig. Station, northern part of Portion 28, Parish Bobundara, County Wallace. The slate in which the graptolites occur is highly metamorphosed with well developed chiastolite.

The following species are represented: *Climacograptus* sp. (*C. caudatus* or *C. wilsoni*), *Dicellograptus* (fragment of large species), *Diplograptus* sp.

Specimens F.44488—F.44507, Australian Museum Collection.

Geological Age.—Upper Ordovician. Zone of *Dicranograptus clingani* (upper horizon of Eastonian of Victoria).

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THE AUSTRALIAN STOMATOPODA (CRUSTACEA) IN THE COLLECTIONS OF THE AUSTRALIAN MUSEUM, WITH A CHECK LIST AND KEY TO THE KNOWN AUSTRALIAN SPECIES

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and Frank McNeill,
Australian Museum.

(Figure 1.)

I. Introduction.

The Museum collection of Stomatopoda is the most extensive existent Australian assemblage of the group, but only a minority of the specimens have been reported upon in publications (see Whitelegge, 1900; McNeill, 1926, 1952; Hynd in MS., 1948; Serène 1950, 1952; Stephenson 1953*a*). In the present paper the entire collection is detailed, and the records add considerably to the known distributions of several species. Eight species recorded from Australia by past workers (including one of us, W.S.) but not present in the collection, are also listed, thus completing a check list of the known Australian species. A comprehensive key is provided, and this includes species which might be confused with the Australian stomatopod fauna, and also widespread Indo-Pacific species which might be found to occur in Northern Australian waters after more intensive investigation.

The synonymy quoted includes the original author, but excludes most other sources prior to Kemp's (1913) monograph. These are only included where Kemp's synonymy appears at fault or where additional or better figures of the species are given.

Lengths of specimens are measured in a mid-dorsal line from the posterior end of the telson (as near as practicable, excluding spines) to the anterior edge of the carapace, excluding the rostrum. Owing to body curvature, the varying extension of the abdomen and, in some cases, the lack of clear demarcation between bases of spines and posterior margins of telsons, lengths are only accurate to about ± 1 per cent.

Records of specimens received at the Zoology Department, University of Queensland too late to be published in earlier papers (Stephenson 1952, 1953 *a*, *b*) have been added to the present collection, and are indicated in the text by asterisks.

Localities are arranged under their respective Australian States, and in cases where locality lists within a State are extensive, a geographical north to south arrangement is presented.

II. The Museum Collection and Additional Records.

Squilla raphidea Fabricius.

Squilla raphidea Fabricius, *Ent. Syst. Suppl.*, 1798, p. 416; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 88-92, Pl. VII, fig. 77; Gravier, *Ann. Inst. Océanogr. Monaco*, XVII, 1937, pp. 186-9, figs. 8-10; Lui, *Contrib. Inst. Zool. Nat. Acad. Peiping*, V, 1, 1949, pp. 43-4, Pl. VII, figs. 15-16; Barnard, *Ann. S. Afr. Mus.*, XXXVIII, 1950, pp. 851-2, fig. 1*c*, *g*; Stephenson, *Zool. Pap. Univ. Q'ld.*, I, 1, 1952, pp. 4-5.

Nine males, 132-253 mm.; seven females, 165-314 mm.

N. Territory: Two specimens, near Emery Point, Darwin Harbour, early 1954, coll. Capt. F. E. Wells, Hbr. Master, seine netted off beach.

Queensland: Cape Flattery, 1898, pres. Capt. Dawson; Cairns Inlet, pres. Dr. P. S. Clarke; Tin Can Bay, near Gympie, 7/vii/1952, coll. C. Lea, from net*; Tampian Beach, Emu Park, Keppel Bay, 14/vii/1935, pres. H. Bernhard, washed ashore; Port Curtis, 1912, pres. local hotel manager; Port Curtis, pres. C. Bedsor.

N.S. Wales: Cowan Creek, Hawkesbury River, 1/ii/1953, coll. H. Adams; Cowan Crk., Hawkesbury R., March 1950, coll. W. H. Mayo, from stomach of large Flathead (fish); near Jerusalem Bay, Hawkesbury R., May 1952, coll. S. W. Wagg, from stomach of Flathead; Jerusalem Bay, Hawkesbury R., 18/v/1952, coll. A. Gay, from hook and line; Hawkesbury R., March 1952, coll. E. L. Mullins, entangled in fisherman's line from depth of 30 ft.; Rose Bay, Port Jackson 10/iii/1925, coll. A. O. Golding, from prawn net; two specimens, Old collection, no specific locality but undoubtedly from N.S. Wales waters.

Previously recorded from the N. Territory (Tate, 1883) and from Queensland (Stephenson, 1952, 1953*b*), but not from N.S. Wales.

Squilla granti Stephenson.

Squilla granti Stephenson, *Aust. J. Mar. F. W. Res.*, 4, 1, 1953, pp. 201-8, fig. 1 A-D, fig. 2 A, B, D, F, G.

Three females, 39-49 mm.; two males, 60 and 65 mm.

Queensland: Scarborough, Moreton Bay, 26/v/1913, dredged (bearing J. S. Hynd's MS. identification "*Squilla microphthalma* M. Edw.")—Paratype; two specimens 5½ miles N.N.E. Woody Point Pier, Moreton Bay, 3/i/1951, coll. E. M. Grant, trawled muddy sand, 12 metres depth—Paratypes; off Point Lookout, S. Queensland, Dec. 1952, coll. M. Drinan, trawled in ocean waters*; almost certainly from Moreton Bay, late 1952, per Q'ld. Dept. Harb. and Marine.*

This recently described species is known only from Queensland.

Squilla depressa (Miers).

Chloridella microphthalma (*depressa*) Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, pp. 14-5, Pl. II, figs. 1-4.

Squilla depressa Serène, Rec. Aust. Mus., XXIII, 1952, pp. 2-11, figs. 3, 4, 9, 18, 21, Pl. I, fig. 3, Pl. II, figs. 3, 6, 7, 8, 9, 10; Stephenson, *Zool. Pap. Univ. Q'ld.*, I, 1952, p. 8; Stephenson, *Aust. J. Mar. F.W. Res.*, 4, 1, 1953, pp. 207-8, fig. 2 E; Stephenson, *Mem. Q'ld. Mus.*, 13, 1, 1953, p. 43.

Male, 74 mm.; two females, 43 and 71 mm.

Queensland: Port Denison, 1921, pres. E. H. Rainford; Great Barrier Reef, 1923, coll. Dr. W. E. J. Paradice, R.A.N.; Mackay, pur. C. Volskow (fisherman).

These specimens were commented upon by Serène in his redescription of the species, which is known only from the N. Territory (Miers, 1880) and Queensland (Serène, 1952; Stephenson, 1952, 1953 *a*, *b*).

Squilla fasciata de Haan.

Squilla fasciata de Haan, *Siebold's Fauna Japonica*, Crust., atlas, 1844, Pl. LI, fig. 4, Crust. (text), 1849, p. 224; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 34-6, Pl. 1, figs. 21-3; Hale, *Rec. S. Aust. Mus.*, II, 4, 1924, p. 496, text-fig. 381 *j*, *k*; Hale, *Crust. S. Aust.*, I, 1927, fig. 21; Gravier, *Ann. Inst. Océanogr. Monaco*, XVII, 1937, pp. 177-9, fig. 1.

Squilla subfasciata Tate, *Trans. Proc. Roy. Soc. S. Aust.*, VI, 1883, p. 52, Pl. II, fig. 1.

Four males, 60-79 mm.; nine females, 37-76 mm.

Queensland: All per Zool. Dept. Univ. Q'ld.:—Trinity Inlet, Cairns, Nov., 1953, coll. G. Rowell, trawled (per Q'ld. Dept. Harb. and Marine); near Townsville, Aug. 1953, trawled R. K. Bryson, about 20 fms.; S.E. edge Pearl Channel, Moreton Bay, 20/xi/1952, trawled E. M. Grant, on muddy sand, 12 metres depth; E.S.E. Redcliffe Jetty, Moreton Bay, 28/iii/1953, trawled E. M. Grant, gritty mud, 12 metres depth; 2 miles E. Redcliffe Jetty, 19/vi/1952, coll. T. C. Marshall, 5 fms. (both raptorial claws missing); 3½ miles S. Woody Point Pier, Moreton Bay, 19/x/1952, trawled E. M. Grant on sandy mud, 8 metres depth; same locality, habitat and collector, 2/xi/1952, 7 metres depth (described by the collector as "egg bearing"); 4 miles N.E. Woody Point Pier, 8/ix/1952, trawled E. M. Grant on shelly mud about 8 metres depth; four specimens, 3 miles N.E. Woody Point Pier, 9/viii/1952, trawled E. M. Grant on sandy mud, 9 metres depth; 3 miles S. Woody Point Pier, 10/xi/1951, trawled E. M. Grant, sandy mud, 6 metres depth.

Within Australia this species is known only from S. Australia (Tate, 1883) and from Queensland, a surprisingly discontinuous distribution.

Squilla fallax Bouvier.

Squilla fallax Bouvier, *C.R. Acad. Sci. (Paris)*, 159, 2, 1914, pp. 698-9; Bouvier, *Bull. Sci. France Belg.*, 48, 1915, pp. 308-11, figs. 39-42.

Male, 51 mm.

N.S. Wales: Off Dawes Point, Port Jackson, Mar. 1933, pres. W. J. Hale, harbour dredge, about 5 fms.

The first Australian record of a rare Indo-Pacific species.

Squilla miles Hess.

Squilla miles Hess, *Arch. f. Naturgesch.*, XXXI, 1, 1865, p. 169, Pl. VII, fig. 21; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 36-7; Odhner, *Med. Göteborgs Mus. Zool. Avd.*, 30, 1923, pp. 1-5, figs. 1-3; Hale, *Rec. S. Aust. Mus.*, II, 4, 1924, pp. 492-5, Pl. XXXII, fig. 1, text-fig. 381 *a-i*.

Squilla pectinata Tate, *Trans. Proc. Roy. Soc. S. Aust.*, VI, 1883, p. 50, Pl. II, figs. 2 *a-d*.

Three males, 49-101 mm.; one female, 64 mm.

Victoria: Port Phillip, coll. J. Gabriel.

Tasmania: Near mouth Don River, N. coast, coll. K. G. Hiscock, May 1953, 3 ft. deep rock pool;* Ralph's Bay, estuary of Derwent River, coll. M. Ward, 2-3 fms.

W. Australia: Albany, exch. W. Aust. Museum.

Sydney, N.S. Wales, is recorded as the type locality of this species, but it is significant that there are no N.S. Wales specimens in the collection or any N.S. Wales records subsequent to Hess (1865). A number of crustacean species recorded by Hess from "Sydney" have not been substantiated since, and in the present case Hess' locality is apparently inaccurate. The species has been recorded from Victoria (Miers, 1880*a*) where it is apparently the dominant stomatopod (Stephenson, 1954), and also from Tasmania (Guiler, 1952; Stephenson, 1954). It is evidently common in S. Australia (Tate, 1883; Odhner, 1923; Hale, 1924, 1927) and extends to W. Australia (Alexander, 1916 *a*).

Squilla mcneilli Stephenson.

Squilla armata Whitelegge, *Mem. Aust. Mus.*, IV, 1900, p. 199 (*nec* M. Edw.).

Squilla mcneilli Stephenson, *Aust. J. Mar. F. W. Res.*, 4, 1, 1953, pp. 213-8, fig. 4A-F.

Sixteen males, 40-85 mm.; thirteen females, 41-86 mm.

N.S. Wales: The specimens have recently been reported upon *in extenso* (Stephenson 1953*a*).

The species is known only from the N.S. Wales coast where it ranges from Newcastle to south of Green Cape. Most specimens were trawled at the unusual depths of from 25-90 fms., and several were from the stomachs of trawled fishes.

Ekman (1953, p. 196) notes the occurrence of *Sq. armata* from S.W. Australia. In a personal communication he gives the source as Balss' (1918) work on the fauna of W. Africa. Balss refers to Whitelegge's misidentification of the present species from N.S. Wales. Ekman's note is therefore based upon a misidentified specimen from a mistaken locality.

Squilla scorpio Latreille.

Squilla scorpio Latreille, *Encycl. Méthod.*, X, 1825, p. 472; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 42-4, Pl. II, fig. 30; Lui, *Contrib. Inst. Zool. Nat. Acad. Peiping*, V, 1, 1949, pp. 27-9, Pl. IV, figs. 1, 2.

Not represented in the collection. Miers' (1880) record from the N. Territory may well refer to the next species (see Stephenson, 1953 *a*).

Squilla terrareginensis Stephenson.

Squilla terrareginensis Stephenson, *Aust. J. Mar. F.W. Res.*, 4, 1, 1953, pp. 208-13, fig. 3A, B.

Two males, 75 and 92 mm.; two females, 54 and 88 mm.

Queensland: Cooktown, 1905, coll. A. R. McCulloch (Allotype female and Paratype male); near mouth Barron River, Cairns, coll. G. A. V. Stanley (Holotype male); Cairns, 25/iv/1953, per Dr. H. Flecker.*

This recently described Queensland species resembles *Sq. scorpio* to a marked degree.

Squilla laevis Hess.

Squilla laevis Hess, *Arch. f. Naturgesch.*, XXXI, 1, 1865, p. 170, Pl. VII, fig. 22; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 49-50, Pl. III, figs. 35-7; Hale, *Rec. S. Aust. Mus.*, II, 4, 1924, Pl. XXXII, fig. 2.

Fifty-six males, 17-114 mm.; fifty-five females, 44-124 mm.

Queensland: Point Lookout, S. Queensland, 31/iii/1945, coll. J. S. Hynd, washed up on beach on floating coconut husk; Jumpinpin, Moreton Bay, 3/i/1946, coll. D. Hanify (per J. S. Hynd); Moreton Bay, coll. J. S. Hynd; Yatala, near Southport, coll. Miss M. Willesden.

N.S. Wales: Eleven specimens labelled "No data", almost certainly from N.S. Wales waters; seventy-seven specimens, Evans Head, May-June 1953, per H. Lane, trawled*; near Morisset, Lake Macquarie, 26/i/1912, in prawn net, pres. N.S.W. State Fisheries; Port Jackson, pres. J. Conran; Sow and Pigs Shoal, Port Jackson, pres. Capt. L. Comtesse (dredge "Triton") about 5 fms.; Rushcutters Bay, Port Jackson, pres. J. Lawler, caught in prawn net; Leichhardt Bay, Parramatta River, Port Jackson, pres. J. Brooks; Parramatta R., Dec. 1928, pres. V. Argent; Parramatta R., pres. W. Barnett, in prawn net; Sydney, 1893; Sydney, pres. W. Reek, in purchase of

penaeid prawns from shop; Sydney (?), 1891; Sydney fish market, pres. R. J. Thorpe; Sydney fish market, pres. G. W. Sherar; Sydney fish market, pres. N.S.W. State Fisheries; Lady Robinson's Beach, Botany Bay, pres. G. W. Walker; Kogarah Bay, George's River, in Botany Bay, pres. J. H. Wright, in prawn net, shallow water.

W. Australia: Swan River, pres. Fish. Inspt. A. Abjornsson, 30 ft. depth; Murray River, near Fremantle, pres. Fish. Inspt. A. J. Fraser; off Geraldton Harbour, pres. Fish. Inspt. R. J. Marsh, from crayfish "pot".

Sydney is the type locality, and Stead (1898) also recorded the species from there. It has been recorded from Victoria (Miers, 1880), S. Australia (Hale, 1924), and from S. W. Australia (Hale, 1929*b*) where it is evidently the dominant stomatopod (Stephenson, 1954). It is very common amongst catches of penaeid prawns from Moreton Bay (Queensland) and, as present records show, from Evans Head and Sydney in N.S. Wales.

Squilla quinquedentata Brooks.

Squilla quinquedentata Brooks, *Voy. H.M.S. "Challenger"*, Zool., XVI, pp. 26-30, Pl. I, fig. 3, Pl. II, fig. 6; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 52-3, p. 195; Holthuis, *Temminckia*, 1941, pp. 244-5.

Male, 50 mm.; female, 138 mm.

N. Territory: Paradice Bay, N. Island, Sir Edw. Pellew Grp., Gulf of Carpentaria, pres. Dr. W. E. J. Paradice, R.A.N., fish trap at night on clean sand, depth 20 ft.

Queensland: Brampton Is., near Mackay, coll. Miss B. Dew, from tidal mud flat.

Until very recently (Stephenson, 1953*b*) this species had not been recorded from Australia, but it is apparently moderately common at Townsville, Queensland. Not recorded previously from the Gulf of Carpentaria.

Squilla foveolata Wood-Mason.

Squilla foveolata Wood-Mason, *Figs. Descr. Nine Squillidae*, 1895, p. 2, Pl. 2, fig. 1; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 58-60, Pl. IV, fig. 48.

Not represented in the present collection. Represented in the Queensland Museum collections and recently recorded from Queensland (Stephenson, 1953*b*).

Squilla nepa Latreille.

Squilla nepa Latreille, *Encycl. Méthod.*, X, 1825, p. 471; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 60-4, p. 195, Pl. IV, fig. 49; Gravier, *Ann. Inst. Océanogr. Monaco*, XVII, 1937, pp. 179-82, figs. 2-3; Barnard, *Ann. S. Afr. Mus.*, XXXVIII, 1950, pp. 847-8, figs. 1*b*, 2*a*.

Not represented in the present collection. Represented in the Queensland Museum collections and recently recorded from Townsville, Queensland (Stephenson, 1953*b*). Doubtfully recorded from Queensland by Miers (1880) and from "Australia" by Henderson (1893).

Squilla wood-masoni Kemp.

Squilla wood-masoni Kemp, *Rec. Ind. Mus.*, VI, 1911, p. 99; Kemp, *Mem. Ind. Mus.*, VI, 1. 1913, pp. 74-6, Pl. V, figs. 63-5; Hansen, *Siboga Exped.*, 104 Livr., Monogr. 35, 1926, p. 12; Chopra, *Rec. Ind. Mus.*, XXXVI, 1935, pp. 26-7; Holthuis, *Temminckia*, VI, 1941, p. 225; Lui, *Contrib. Inst. Zool. Nat. Acad. Peiping*, V, 1, 1949, pp. 42-3, Pl. VI, figs. 12-14; Stephenson, *Zool. Pap. Univ. Q'ld.*, I, 1, 1952, pp. 5-6.

Ten males, 59-141 mm.; twelve females, 72-134 mm.

N. Territory: Port Darwin, 1879, coll. A. Morton; Sir Edward Pellew Group, Gulf of Carpentaria, pres. Dr. K. Hudson, seine netted (Reg. No. P.8450); near Emery Point, Darwin Harbour, early 1954, coll. Capt. F. E. Wells, Hbr. Master, seine netted off beach.

Queensland: Two specimens, mouth of Norman River, Gulf of Carpentaria, Aug. 1953, coll. T. C. Marshall, 1-2 fms., mud*; four specimens, Townsville, Sept. 1952, trawled G. Coates, per T. C. Marshall*; Magnetic Is., near Townsville, March 1953, coll. R. K. Bryson, trawled 9 fms.*; Moreton Bay, per Q'ld. Dept. Harb. and Marine*.

N.S. Wales: Evans Head, May-June 1953, per H. Lane, trawled*; Folly Point, Middle Harbour, Port Jackson, pres. C. Wheatley.

W. Australia: Two specimens, Exmouth Gulf, 5/ix/1953, coll. K. Sheard, trawled, 7 fms.*; three specimens, mouth of Trubridge Creek, Exmouth Gulf, 12/ix/1952, coll. K. Sheard, P.V. "Lancelin", trawled 2 fms.*; three specimens, Learmouth, Exmouth Gulf, 13/ix/1953, coll. K. Sheard, P.V. "Lancelin", otter prawn trawl, 9 fms.*; E.N.E. of White Is., Sharks' Bay, coll. K. Sheard, P.V. "Lancelin", otter trawl, 4-6 fms.*.

The Gulf of Carpentaria specimen, Reg. No. P.8450, has the left submedian denticle of the telson missing, and the entire postero-central area of the telson is malformed.

Previously recorded from N.S. Wales (Kemp, 1913); S.E. Queensland (Stephenson, 1953 *a, b*), but not from the Gulf of Carpentaria, the N. Territory or W. Australia.

Squilla interrupta Kemp.

Squilla interrupta Kemp, *Rec. Ind. Mus.*, VI, 1911, p. 98; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 72-4, Pl. V, figs. 60-2; Boone, *Bull. Vanderbilt Mar. Mus.*, V, 1934, pp. 28-31, Pl. 7; Tweedie, *Bull. Raffles Mus.*, 10, 1935, p. 48; Holthuis, *Temminckia*, VI, 1941, pp. 252-4; Lui, *Contrib. Inst. Zool. Nat. Acad. Peiping*, V, 1, 1949, pp. 39-41, text-fig. 3*a-b*.

Two males, 135 and 147 mm.; four females, 79-153 mm.

Queensland: Brisbane River (?), 9/vi/1945, coll. J. S. Hynd; Brisbane R., 19/xi/1953, coll. N. M. Hayson, trawled*; 7 miles N.E. Woody Point Pier, Moreton Bay, 19/xii/1950, coll. E. M. Grant, trawled 13 metres depth, sandy mud and shell grit*; Deception Bay, in Moreton B., Oct. 1952, trawled A. Keong*; Port Curtis, pres. C. Bedsor.

N.S. Wales: Port Jackson, Old collection, pres. Dr. G. Bennett.

This species is common in S.E. Queensland (Boone, 1934; Stephenson, 1952, 1953*b*) but has not been reported hitherto from N.S. Wales.

Squilla inornata Tate.

Squilla inornata Tate, *Trans. Proc. Roy. Soc. S. Aust.*, VI, 1883, p. 51, Pl. II, figs. 3*a-c*; Stephenson, *Mem. Q'ld. Mus.*, 13, 1, 1953, pp. 41-2.

Squilla affinis var. *intermedia* Nobili, *Bull. Mus. Zool. Anat. Comp. Torino*, 18, 455, 1903, p. 3.

Squilla oratoria var. *perpensa* Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 70-2, Pl. V, figs. 57-9.

Squilla oratoria var. *inornata* Hale, *Rec. S. Aust. Mus.*, II, 4, 1924, pp. 495-6; Chopra, *Rec. Ind. Mus.*, XXXVI, 1935, pp. 24-5; Gravier, *Ann. Inst. Océanogr.*, XVII, 1937, pp. 183-5, fig. 6; Holthuis, *Temminckia*, VI, 1941, pp. 248-9; Lui, *Contrib. Inst. Zool. Nat. Acad. Peiping*, V, 1, 1949, pp. 37-8, figs. 2*a-b*.

Squilla oratoria inornata Tweedie, *Bull. Raffles Mus.*, 10, 1935, pp. 45-8.

Male, 55 mm.; female, 85 mm.

Queensland: Port Denison, 1921, pres. E. H. Rainford; Mapoon, coll. C. Hedley.

Previously recorded from N. Territory (Miers, 1880); Queensland (Hale, 1924; Stephenson, 1953*b*) and S. Australia (Tate, 1883).

Squilla anomala Tweedie.

Squilla anomala Tweedie, *Bull. Raffles Mus.*, 10, 1935, pp. 45-8; Holthuis, *Temminckia*, VI, 1941, p. 253; Stephenson, *Zool. Pap. Univ. Q'ld.*, I, 1, 1952, pp. 7-8.

Two males, 93 mm. and 111 mm.; female, 133 mm.

Queensland: Off Lindeman Is., Cumberland Group, trawled G. P. Whitley, 10 fms.; two specimens, 4 miles E. Scarborough Pier, Moreton Bay, 3/xi/1951, coll. E. M. Grant, trawled 12 metres depth, sandy mud*.

Apart from Queensland records (see Stephenson, 1952, 1953*b*), this species is known only from Singapore.

Pseudosquilla ciliata (Fabricius).

Squilla ciliata Fabricius, *Mantiss Insect.*, I, 1787, p. 333.

Pseudosquilla ciliata Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, p. 108, p. 458, Pl. III, figs. 7, 8; Kemp. *Mem. Ind. Mus.*, IV, 1, 1913, pp. 96-100; Bigelow, *Bull. Mus. Comp. Zool. Harv.*, LXXII, 4, 1931, pp. 152-60, text-figs. 3-6; Boone, *Bull. Vanderbilt Mar. Mus.*, V, 1934, pp. 16-20, Pl. 4; Gravier, *Ann. Inst. Océanogr.*, XVII, 1937, pp. 91-3; Barnard, *Ann. S. Afr. Mus.*, XXXVIII, 1950, pp. 852, 854, fig. 3*a*; Townsley, *Pacific Sci.*, VII, 4, 1953, pp. 412-5, figs. 10, 11*a-m*.

Seven males, 48-62 mm.; six females, 56-73 mm.

Queensland: Darnley Is., 30/viii/1953, coll. D. J. Tranter, from *Zostera* pools*; six specimens, Murray Is., 1907, coll. C. Hedley and A. R. McCulloch; Palm Island Group, coll. J. S. Hynd; Caloundra, coll. Dr. T. H. Johnston; Myora, Moreton Bay, 4/iv/1946, coll. J. S. Hynd, mud flat; Myora, 28/vii/1946, coll. J. S. Hynd, on sand-banks; Dunwich, Stradbroke Is., Moreton B., Oct. 1953, coll. T. C. Marshall*; N. of Dunwich Lab., Stradbroke Is., 2/viii/1952, coll. W. Stephenson, dug in sand mud, *Zostera* flat*.

Frequently recorded from Queensland (Kemp, 1913; Hale, 1929 *a*; Riek, in MS. 1941; Hynd, in MS. 1948; Stephenson, 1952, 1953 *b*) but as yet not from any other State. Miers' (1880) locality is merely "Australia".

Pseudosquilla pilaensis de Man.

Pseudosquilla pilaensis de Man, *J. Linn. Soc.*, XXII, 1888, p. 296; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 105-6; Smith. *Lignan Sci. J.*, 8, 1929, pp. 140-3, Pl. 19, figs. 12-14; Gravier, *Ann. Inst. Océanogr. Monaco*, XVII, 1937, pp. 193-4, fig. 13.

Not represented in the present collection but present in the Queensland Museum collections and recorded from Bowen, Queensland (Stephenson, 1953 *b*).

Lysiosquilla perpasta Hale.

Lysiosquilla perpasta Hale, *Rec. S. Aust., Mus.*, II, 4, 1924, pp. 497-9, Pl. XXXIII, fig. 1, text-fig. 382; Hale, *Crust. S. Aust.*, I, 1927, p. 33, fig. 23.

Twenty-six males, 15-45 mm.; twenty-six females, 21-55 mm.

Queensland: All specimens per Zool. Dept. Univ. Q'ld. Eleven specimens, Dunwich, Stradbroke Is., Moreton Bay, 19/vii/1952, coll. R. Domrow, under dead coral stones on flats; N. of Dunwich Lab., Stradbroke Is., 2/viii/1952, coll. W. Stephenson, in burrow with egg mass in sandy mud on *Zostera* flat; four specimens, Polka Point, Dunwich, 4/vii/1953, coll. W. Stephenson, dug in sand and mud amongst *Zostera*; four specimens, Myora, Moreton B., 19/vi/1952, coll. Miss N. Lavis, under dead coral clumps; five specimens, Myora, 22/x/1952, coll. E. M. Grant, in sand near *Zostera*, extreme L. W. Springs; three specimens, labelled "In Biol. Dept. [Q'ld Univ.] collections, no locality or date" (in J. S. Hynd collections); vicinity of Brisbane, probably Moreton B.

N.S. Wales: Long Reef, Collaroy, 28/xi/1929, coll. F. A. McNeill; seven specimens, Eastern Channel, off Sow and Pigs Shoal, Port Jackson, July-Oct. 1929, pres. Capt. L. Comtesse, dredge "Triton", about 6 fms.; four specimens, Kurnell, Botany Bay, 27/x/1927, coll. F. A. McNeill and party, in sand and shell grit at low tide mark; seven specimens, Kurnell, 22/i/1928, coll. M. Ward, reef between tide marks; George's River, Botany Bay, 1925, pres. A. A. Livingstone, in mud between tide marks, two specimens, Gunnamatta Bay, Port Hacking, coll. F. A. McNeill, dug from sand of tidal flat; Shellharbour, 1926, coll. G. McAndrew, between tide marks.

Victoria: Seaport, Port Phillip, Jan. 1926, coll. M. Ward, under stones below tide mark.

An indigenous species described from S. Australia (Hale, 1924) and since recorded from Queensland (Stephenson, 1952, 1953 *b*) where it is common in Moreton Bay. Present records show it is equally common near Sydney, and in addition it has recently been recorded from Victoria and Tasmania (Stephenson, 1954).

Lysiosquilla maculata (Fabricius).

Squilla maculata Fabricius, *Ent. Syst.*, II, 1893, p. 511.

Lysiosquilla maculata Dana, *U.S. Explor. Exped.*, Crust., 1852, p. 606; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 111-6, Pl. VIII, figs. 86-92; Edmondson, *Occ. Pap. Bernice P. Bishop Mus.*, VII, 13, 1921, fig. 1 *d*; Bigelow, *Bull. Mus. Comp. Zool. Harv.*, LXXII, 4, 1931, pp. 169-73, text-figs. 9A, B; Boone, *Bull. Vanderbilt Mar. Mus.*, V, 1934, pp. 21-8, Pls. 5, 6; Chopra, *Rec. Ind. Mus.*, XXXVI, 1935, pp. 28-30; Barnard, *Ann. S. Afr. Mus.*, XXXVIII, 1950, pp. 855-6, fig. 3 *d*; Townsley, *Pacific Sci.*, VII, 4, pp. 216-9, figs. 14, 15 *a-g*; Stephenson, *Mem. Q'ld. Mus.*, 13, 1, 1953, pp. 44-5.

Lysiosquilla miersi De Vis, *Proc. Linn. Soc. N.S.W.*, VII, 1883, p. 321; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 116-7, Pl. VIII, figs. 86-91.

Two males, 109 and 263 mm.; female, 138 mm.

N.S. Wales: Off Port Jackson, 10/iv/1954, coll. H. Bates, from hook and line, 20 fms.

W. Australia: N.W. Australia, coll. Dr. J. H. Cumpston, from burrow in tidal mud flat; Broome, coll. B. Bardwell.

A tropical species common in Queensland and extending normally to about the N.S. Wales border (Stephenson *et al.*, 1931; Dakin, 1950; Bennett in MS. 1950; Stephenson, 1952, 1953 *b*); only an extremely rare wanderer would be found in the more southerly temperate waters. There are three previous records from W. Australia (Alexander, 1916 *a*, *b*; Stephenson, 1953 *b*) and there are several further specimens in the Museum of W. Australia which one of us (W.S.) has had the privilege of examining.

Lysiosquilla vercoi Hale.

Lysiosquilla vercoi Hale, *Rec. S. Aust. Mus.,* II, 4, 1924, pp. 499-501, Pl. XXXIII, fig. 2, text-fig. 383; Hale, *Crust. S. Aust.,* I, 1927, pp. 33-4, fig. 24; Stephenson, *Mem. Q'ld. Mus.,* 13, 1, 1953, p. 46.

Two males, 44 and 52 mm.; female, 49 mm.

N.S. Wales: Kingscliff, S. of Tweed Heads, 1953, coll. Mrs. J. Kirchner, dug from sand, ocean beach; Gerringong, pres. A. O'Sullivan.

Victoria: Port Phillip, coll. C. J. Gabriel.

The Victorian specimen has 13 teeth and the N.S. Wales specimen 20 on the raptorial dactylus.

An indigenous species described from S. Australia (Hale, 1924, 1927), since recorded from Queensland (Stephenson, 1953*b*) and Tasmania (Stephenson, 1954) and now from the intermediate States of Victoria and N.S. Wales.

Lysiosquilla osculans Hale.

Lysiosquilla vercoi var. *osculans* Hale, *Rec. S. Aust. Mus.,* II, 4, 1924, pp. 501-2, Pl. XXXIII, fig. 3, text-fig. 384.

Lysiosquilla osculans Hale, *Crust. S. Aust.,* I, 1927, p. 34, fig. 24.

Male, 41 mm.; female, 29 mm.

Victoria: Beaumaris, Port Phillip, Jan. 1926, coll. M. Ward; Port Phillip, pres. C. J. Gabriel.

An indigenous species known only from S. Australia (Hale, 1924, 1927) and Victoria (Stephenson, 1954).

Lysiosquilla acanthocarpus Miers.

Lysiosquilla acanthocarpus Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, p. 11, Pl. 1, figs. 7-9; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 120-2; Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.,* Ser. B, III, 1927, pp. 30-1; Serène, Rec. Aust. Mus., XXIII, 1952, pp. 12-14, figs. 25-7 (synonymy).

Female, 79 mm.

N. Territory: Paradice Bay, North Is., Sir Edw. Pellew Group., G. of Carpentaria, coll. Dr. W. E. J. Paradice, R.A.N., on sand flat.

This specimen has been reported upon by Serène (1952). The type locality is Port Essington (N. Territory).

Lysiosquilla multifasciata Wood-Mason.

Lysiosquilla multifasciata Wood-Mason, *Figs. Descr. Nine Squillidae,* 1895, p. 1, Pl. I, figs. 4-7; Kemp. *Mem. Ind. Mus.,* IV, 1, 1913, pp. 122-4; Chopra, *John Murray Exped. Sci. Rep.,* 2, 1939, pp. 162-5, figs. 8, 9; Tweedie, *Bull. Raffles Mus.,* 19, 1949, p. 39, fig. 1*a, b*; Serène, Rec. Aust. Mus., XXIII, 1952, pp. 11-12 (synonymy).

Female, 61 mm.

Queensland: Dunk Is., Family Group, coll. E. J. Banfield.

Reported upon recently by Serène (1952) as a new Australian record of a rare but widespread species.

Lysiosquilla latifrons (de Haan).

Squilla latifrons de Haan, *Siebold's Fauna Japonica,* Crust., Atlas, 1844, Pl. LI, fig. 3; Crust., Text, 1849, p. 222.

Lysiosquilla latifrons Miers, *Ann. Mag. Nat. Hist.* (5), V, pp. 10, 125; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 128-9; Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.,* Ser. B, III, 1927, pp. 333-5, Pl. XIV, figs. 3, 3*b*.

Lysiosquilla brazieri Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, pp. 11, 125, Pl. I, figs. 3-6; Haswell, *Cat. Aust. Crust.,* 1882, p. 206.

Female, 75 mm.

N.S. Wales: Port Jackson, coll. Mr. Tiley, dredge "Samson".

The only previous Australian record (Miers, 1880 *a*) is also from Port Jackson.

Odontodactylus cultrifer (White).

Gonodactylus cultrifer White, *Proc. Zool. Soc.,* 1850, pp. 96-7, Pl. XVI, figs. 1, 2.

Gonodactylus carnifer Pocock, *Ann. Mag. Nat. Hist.* (6), XI, 1893, p. 478, Pl. XXV, figs. 4, 4*a*, 4*b*.

Odontodactylus cultrifer Bigelow, *Proc. U.S. Nat. Mus.,* XVII, 1894, p. 496; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 137-8; Sunier, *Contrib. Faun. Indes Nèerland. Inst. Sci. Buitenzorg,* I, 1915-18, pp. 72-4; Kemp & Chopra, *Rec. Ind. Mus.,* XXII, 22, 1921, pp. 307-8; Hansen, *Siboga Exped.,* Livr. 104*e*, *Monogr.* XXXV, 1926, p. 23; Stephenson, *Zool. Pap. Univ. Q'ld.,* I, 1, 1952, pp. 10-11.

Odontodactylus carnifer Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 138-9.

Two males, 100 and 115 mm.; three females, 72-100 mm.

Queensland: All per Zool. Dept., Univ. of Q'ld.:—Near Townsville, Aug. 1953, trawled R. K. Bryson, about 20 fms.; Magnetic Is., near Townsville, March 1953, trawled R. K. Bryson, 9 fms.; off Peel Is., Moreton Bay, 6/ix/1952, coll. L. Sandars, with hook and line; two specimens, about 4 miles E. of Woody Point Pier, Moreton B., 22/vii/1951, trawled E. M. Grant, on sandy mud.

Only recently recorded from Australia, and only from Queensland (Stephenson, 1952, 1953 *b*).

Odontodactylus scyllarus (Linn.).

Cancer scyllarus Linn., *Syst. Nat.,* 12th ed., I, ii, 1767, p. 1054.

Odontodactylus scyllarus Borradaile, *Proc. Zool. Soc.,* 1898, p. 36, Pl. V, fig. 6; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 135-7; Kemp & Chopra, *Rec. Ind. Mus.* XXII, 22, 1921, pp. 307-8; Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.,* Ser. B, III, 1927, pp. 335-6, Pl. XIII, fig. 2; Gravier, *Ann. Inst. Océanogr. Monaco,* XVII, 1937, pp. 200-2, figs. 17-19.

Not represented in the present collection but represented in Q'ld. Mus. collections, and recently recorded from Queensland (Stephenson, 1953 *b*).

Odontodactylus japonicus (de Haan).

Gonodactylus japonicus de Haan, *Siebold's Fauna Japonica,* Crust., Atlas, 1844, Pl. LI, fig. 7; Crust. Text, 1849, p. 225.

Odontodactylus japonicus Bigelow, *Proc. U.S. Nat. Mus.,* XVII, 1894, p. 496. Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 139-40; Komai, *Mem. Coll. Sci. Kyoto Imp. Univ.,* Ser. B, III, 1927, pp. 336-8, Pl. XIII, figs. 3-4; Bigelow, *Bull. Mus. Comp. Zool. Harv.,* LXXII, 4, 1931, pp. 145-7, Pl. I, fig. 1.

Not represented in the present collection. Recorded from Broome, W. Australia, by Alexander (1916 *b*), but as there are no specimens in the W. Australian Museum, it is just conceivable that Alexander's material was *O. cultrifer* which is common at equivalent latitudes on the east coast of Australia.

Gonodactylus spinoso-carinatus Fukuda.

Gonodactylus spinoso-carinatus Fukuda, *Annot. Zool. Japan,* VII, 1910, p. 143, Pl. IV, figs. 2, 2*a*; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 173-4; Serène, Rec. Aust. Mus., XXIII, 1, 1952, pp. 14-16, figs. 28-32.

Male, 18 mm.; female, 16 mm.

Queensland: Two specimens, reef, North West Is., Capricorn Grp., Dec. 1931, coll. F. A. McNeill.

These are the only known Australian specimens (see Serène, 1952).

Gonodactylus falcatus (Forskål).

Cancer falcatus Forskål, Descr. Anim., 60, 1775, p. 96.

Gonodactylus glabrous Brooks, *Voy. H.M.S. "Challenger",* Zool. XVI, 1886, pp. 62-4, Pl. XIV, fig. 5, Pl. XV, figs. 7, 9; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 167-9, Pl. IX, fig. 113, fig. 2 on p. 170; Bigelow *Bull. Mus. Comp. Zool. Harv.,* LXXII, 4, 1931, pp. 127-35, text-fig. 1; Boone, *Bull. Vanderbilt Mar. Mus.,* V, 1934, pp. 13-16, Pl. 3; Gravier, *Mém. Inst. égypt.,* 37, 1938, pp. 178-83, fig. 5*d*; Barnard, *Ann. S. Afr. Mus.,* XXXVIII, 1950, p. 863, fig. 3*f*.

Gonodactylus glaber Henderson, *Trans. Linn. Soc.,* Zool. (2), V, 1893, p. 454.

Gonodactylus falcatus Holthuis, *Temminckia,* VI, 1941, pp. 484-8, fig. 9*a* (synonymy); Stephenson, *Zool. Pap. Univ. Q'ld.,* I, 1, 1952, pp. 11-12; Stephenson, *Mem. Q'ld. Mus.,* 13, 1, 1953, p. 47.

Thirty-seven males, 17-61 mm.; fifty-four females, 19-73 mm.

Queensland: Five specimens, Murray Is., 1907, coll. C. Hedley and A. R. McCulloch; three specimens, Cairns Reef, off Cooktown, 1905, coll. A. R. McCulloch; two specimens, Dunk Is., Family Group, coll. E. J. Banfield, from cavities of dead and worn corals; Palm Islands Group, June 1926, Old collection, per J. S. Hynd; Palm Islands Grp., 1921, coll. E. H. Rainford, mangrove mud flat; Hook Reef, E. of Bowen, 1926, coll. Surg. Lieut. L. Lockwood, H.M.A.S. "Moresby"; two specimens, Mapoon, coll. C. Hedley; eight specimens, Masthead Is., Capricorn Group, purch. widow of late F. E. Grant; five specimens, Masthead Is., coll. A. R. McCulloch; two specimens, Masthead Is., Nov.-Dec. 1913, coll. A. R. McCulloch; Masthead Is., Old collection, 17 fms.; three specimens, reef, North West Is., Capricorn Grp., Dec. 1925, coll. G. P. Whitley; Heron Is., Capricorn Grp., June 1947, coll. J. S. Hynd; Bulcock Beach Rocks, Caloundra, Aug. 1945, coll. J. S. Hynd; two specimens, Myora, Stradbroke Is., Moreton Bay, 8/iii/1946, coll. J. S. Hynd, coral patch, from *Acropora;* Myora, Stradbroke Is., 19/vii/1952, coll. Miss N. Darveneza, pool under rock, L. W. Springs.*

Lord Howe Island: Four specimens, 1888, purch. E. H. Saunders; two specimens, 1898, "Thetis" Expedition; five specimens, 1899, coll. J. B. Waterhouse; eleven specimens, 1899, coll. Mrs. T. Nichols; six specimens, 1900, coll. Mrs. T. Nichols; 1900, coll. Mr. Thompson; two specimens, 1902, coll. W. S. Thompson; four specimens, 1902, coll. Mrs. T. Nichols; 1902, coll. F. Farnell; nine specimens, coll. Mrs. T. Nichols, Old collection; Feb.-Mar. 1921, coll. A. R. McCulloch; two specimens, coll. A. R. McCulloch and E. Troughton; two specimens, Old collection; two specimens, coll. Mr. Langley.

A common warm-water species with records from Queensland (Henderson, 1893; McNeill, 1926; Hale, 1929 *a*; Boone, 1934; Roughley, 1936; Dakin, 1950; Stephenson, 1952, 1953 *b*) and W. Australia (Alexander, 1916 *a*; Hale, 1929 *b*; Glauert, W. Aust. Mus., in MS.).

Gonodactylus graphurus Miers.

Gonodactylus graphurus Miers, *Ann. Mag. Nat. Hist.* (4), XVI, 1875, p. 344; Brooks, *Voy. H.M.S. "Challenger"*, Zool., XVI, 1886, pp. 58-62, Pl. XIV, figs. 1, 4, 6, Pl. XV, figs. 3, 8; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 169-71, fig. 1 on p. 170; Gravier, *Ann. Inst. Océanogr. Monaco,* XVII, 1937, pp. 205-7, figs. 21-2.

Twenty-six males, 13-76 mm.; twenty-three females, 13-78 mm.

N. Territory: Two specimens, Port Darwin, 1930, pres. L. B. Wilson; Indian Is., Bynoe Harbour, near Port Darwin, coll. Dr. W. E. J. Paradice, R.A.N., among rocks; two specimens, Rail pier, Port Darwin, coll. Dr. W. E. J. Paradice, from amongst marine growths on piles.

Queensland: Sixteen specimens, Little Lagoon, Port Langdon, Groote Eylandt —lat. 13° 51′ 0″ S: long. 136° 51′ 15″ E, 20/vii/1952, coll. J. L. Wassell, 1 fm. in coral and sponge clusters*; four specimens, Green Is., near Cairns, coll. C. Hedley, Old collection; Dunk Is., Family Group, coll. E. J. Banfield; seven specimens, Port Denison, coll. E. H. Rainford; Port Denison, coll. A. Morton, Old collection; eight specimens, Port Denison, Old collection; four specimens, Shoal Point, Mackay, 25/viii/1953, coll. W. Stephenson and party, under rocks, L.W.S.*; Curtis Channel, Port Curtis, 30/viii/1946, coll. J. S. Hynd, 23 fms.; Great Sandy Strait, near mouth Mary River, 7/vi/1946, coll. J. S. Hynd, from encrusting sponge, 1-2 fms.

W. Australia: One specimen, Old collection—no specific locality.

Recorded from the N. Territory (Miers, 1880*b*; Tate, 1883); Queensland (Miers, 1880*b*; Haswell, 1882; Miers, 1884; Brooks, 1886; Ortmann, 1894; Kemp, 1913; Hynd in MS. 1948; Stephenson, 1952, 1953*b*) and W. Australia (Miers, 1880*b*; Balss, 1921). Like *G. falcatus,* it is common in the warmer waters of Australia.

Gonodactylus demani Henderson.

Gonodactylus demani Henderson†, *Trans. Linn. Soc.* Zool. (2), V. 1893, p. 455, Pl. XI, figs. 23, 24; Nobili, *Ann. Sci. Nat. Zool.* (9), IV, 1906, p. 330; Nobili, *Bull. Sci. France Belg.*, XL, 1906, p. 158; Borradaile, *Trans. Linn. Soc.*, Zool. (2), XII, 1907, pp. 210, 212; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 164-5, Pl. IX, figs. 108-11; Holthuis†, *Temminckia* VI, 1941, pp. 282-4, figs. 8*a*, *b* (later synonymy).

Male, 22 mm.

Queensland: Green Is., near Cairns, C. Hedley, Old collection. A new Australian record.

Gonodactylus chiragra (Fabricius).

Squilla chiragra Fabricius, *Species Insectorum,* I, 1781, p. 515.

Gonodactylus chiragra Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 155-62, Pl. IX, fig. 107, fig. 2 on p. 161 (earlier synonymy); Bigelow, *Bull. Mus. Comp. Zool. Harv.*, LXXII, 4, 1931, pp. 113-6, Pl. 2, fig. 1; Boone, *Bull. Vanderbilt Mar. Mus.*, V, 1934, pp. 11-13, Pl. 1, figs. 2A, B; Gravier, *Ann. Inst. Océanogr. Monaco,* XVII, 1937, pp. 202-4; Holthuis, *Temminckia,* VI, 1941, pp. 277-8.

Gonodactylus platysoma Wood-Mason, *Figs. Descr. nine Squillidae,* 1895, p. 11, Pl. III, figs. 3-9.

† Henderson, 1893 and Holthuis, 1941, spell the specific name with a double "i".

Gonodactylus chiragra var. *acutus* Lanchester, *Fauna Geog. Maldives and Laccadives*, 1903, I, p. 447, Pl. XXIII, figs. 3, 3*a*.

Gonodactylus chiragra var. *platysoma* Kemp. *Mem. Ind. Mus.*, IV, 1, 1913, pp. 162-3, fig. 1 on p. 161; Bigelow, *Bull. Mus. Comp. Zool. Harv.*, LXXII, 4, 1931, pp. 117-20, Pl. I, fig. 2, Pl. II, fig. 2; Lunz, *Bull. Bingham Oceanogr. Coll.* 5, 5, 1937, pp. 1-4, fig. 1.

Thirty-one males, 42-82 mm.; forty females, 13-88 mm.

N. Territory: Six specimens, Port Darwin, 1902, pres. Messrs. Christie and Godfrey; two specimens, Port Darwin, 11/xi/1927, pres. L. B. Wilson; two specimens, Port Darwin, 1936, pres. F. Reynolds Morris, 3 fms.; two specimens, Old collection, with locality "North Australia" (Reg. Nos. P.1761-2).

Queensland: Darnley Is., pres. Mrs. W. Miller; Darnley Is., 30/viii/1953, coll. D. J. Tranter in grassy pools at M.T. Level (abundant)*; twelve specimens, Murray Is., 1907, coll. C. Hedley and A. R. McCulloch (including Reg. Nos. P.3131, P.3132, P.3135); two specimens, Cairns Reef, off Cooktown, 1905, coll. A. R. McCulloch; six specimens, outer edge St. Crispin Reef, off Port Douglas, 1918, coll. A. R. McCulloch (includes two specimens with Reg. No. P.4297); Coates Reef, off coast near Cairns, 1924, coll. Dr. W. E. J. Paradice, R.A.N. (Reg. No. P8032); Green Is., near Cairns, 1905, coll. A. R. McCulloch (Reg. No. P.3846); Green Is., 1901, coll. C. Hedley; reef, High Is., Frankland Group, July 1924, coll. Dr. W. E. J. Paradice, R.A.N.; reef, Frankland Grp., between 17° and 19° S. lat., 1924, coll. Dr. W. E. J. Paradice, R.A.N.; two specimens, Dunk Is., Family Group, coll. E. J. Banfield; two specimens, Palm Islands Group, near Townsville, Sept. 1953, coll. G. Coates, in coral reef*; Palm Islands Grp., 1921, coll. E. H. Rainford, mangrove mud flat; eight specimens, Port Denison, 1918, coll. E. H. Rainford; two specimens, Port Denison, Old collection; two specimens, Saddleback Is., near Port Denison, 1921, coll. E. H. Rainford; two specimens, Hook Reef, E. of Bowen, 1926, coll. Surg. Lieut. L. Lockwood, H.M.A.S. "Moresby"; reef, Hayman Is., Cumberland Group, Sept. 1946, coll. Drs. Mackerras, upper flat*; Masthead Is., Capricorn Group, coll. A. R. McCulloch; two specimens, Masthead Is., purch. widow late F. E. Grant; two specimens, reef, North West Is., Capricorn Grp., Dec. 1925, coll. G. P. Whitley (Reg. No. P.8581); Heron Is., Capricorn Grp., June 1947, coll. J. S. Hynd; juvenile, Curtis Channel, Port Curtis, 30/viii/1946, coll. J. S. Hynd, 23 fms.; Bird Is., Moreton Bay, June 1938, coll. J. S. Hynd; Myora, Stradbroke Is., Moreton B., July 1939, coll. J. S. Hynd, from coral.

W. Australia: Two specimens, North-west coast of Australia, 1877, pres. Capt. Walcott, R.N.; Broome, 26/viii/1952, coll. K. Sheard*.

Kemp (1913) commented on the considerable variation within this species and concluded that, of most of the previously described varieties (see, for example, Lanchester 1903 and Borradaile 1907) only Wood-Mason's (1895) *Gonodactylus chiragra* deserved separate segregation. He separated this form as var. *platysoma* by six characters: (1) a wider body, with the greatest breadth of the abdomen between 21.5% and 23.5% of the total length *including* rostrum and tips of the telson; as against less than 20% in the typical form; (2) a shorter raptorial dactylus which is only very slightly bent at the tip; (3) telsonic keels narrow; (4) median telsonic keel not anchor shaped and not ending in a spine; (5) no lateral marginal teeth on the telson; (6) two black spots on the first abdominal somite in alcohol preserved specimens.

In the present collection seven specimens (Reg. Nos. P.1761, P.1762, P.3135, P.3846, P.4297 ♂ and ♀, P.8032) possess this combination of characters, having breadth/length ratios of 21.6%-23.5%. A further specimen (Reg. No. P.3131) agrees in details (2), (3), (4), (5), and (6), and has a breadth/length ratio of 20.5%. Two further specimens (Reg. Nos. P.3132, P.8581) also agree in details (2)-(6) but have breadth/length ratios of 19.8% and 19.5% respectively. These last three specimens,

which are connected by intermediate forms to typical *chiragra*, are evidently *chiragra* themselves. If so, var. *platysoma* retains its independence by virtue of a single character, the breadth/length ratio. In addition the margin of distinction becomes narrower, with var. *platysoma* having ratios of 21.5% and upwards, and *chiragra* having ratios of 20.5% and lower.

The breadth/length ratio is difficult to measure precisely because of varied degrees of telescoping and flexure in the abdominal somites. For example, in one specimen (P.8581) by stretching the specimen very slightly the ratio becomes 19.7% while when slightly telescoped it becomes 20.6%. In addition the ratios vary very greatly in different specimens of typical *chiragra*, from just over 18% to 20.5%. It is concluded that the continued segregation of var. *platysoma* cannot be justified. If so, Lanchester's (1903) var. *acutus* also falls into the synonymy.

G. chiragra is one of the commonest stomatopods in the warmer waters of Australia, with its habitat under stones and coral. It has been recorded from Queensland by Miers, 1880*b*; Haswell, 1882; Miers, 1884; McNeill, 1926; Ward, 1928; Hale, 1929*a*; Stephenson *et al.*, 1931; Foxon, 1932; Hynd in MS., 1948; Dakin, 1950; Bennett in MS., 1950; Stephenson, 1952, 1953*b*. There are also records from N. Australia (Miers, 1880*b*; Tate, 1883; Pocock, 1893), and from W. Australia (Miers, 1880*b*; Pocock, 1893; Alexander, 1916*a*, *b*; Balss, 1921; and Glauert, W. Aust. Mus. in MS.).

Gonodactylus tweediei Serène.

Gonodactylus tweediei Serène, *Bull. Mus. Hist. Nat.* (*Paris*) (2), XXII, 5, 1950, pp. 571-2; Serène, Rec. Aust. Mus., XXIII, 1, 1952, pp. 16-9, fig. 33.

Two males, 20 and 21 mm.; three females, 19-24 mm.

Queensland: North West Is., Capricorn Group, May, 1931, coll. T. Iredale and G. P. Whitley.

Lord Howe Island: Two specimens, Feb.-Mar. 1921, coll. A. R. McCulloch; April 1932, Erskine Channel, coll. A. A. Livingstone, 4 fms.; Elizabeth Reef, N. of Is., April 1936, coll. G. P. Whitley.

Apart from the present specimens (Serène's 1950 types) another Queensland specimen has been noted (Stephenson, 1952).

Gonodactylus pulchellus Miers.

Gonodactylus trispinosus var *pulchellus* Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, p. 122.

Gonodactylus pulchellus Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 177-9, Pl. X, figs. 117-8; Gravier, *Ann. Inst. Océanogr. Monaco*, XVII, 1937, pp. 207-8.

Female, 35 mm.

Queensland: Hayman Is., Cumberland Group, Jan. 1934, coll. F. A. McNeill, dredged in 5 fms.

Recorded once previously from Australia by Hale (1929*a*) from Princess Charlotte Bay, Queensland.

Gonodactylus trispinosus Dana.

Gonodactylus trispinosus Dana, *U.S. Explor. Exped.*, Crust., 1852, p. 623; Kemp, *Mem. Ind. Mus.*, IV, 1, 1913, pp. 180-1.

Protosquilla trispinosa Borradaile, *Proc. Zool. Soc.*, 1898, p. 33, Pl. V, figs. 1, 1*a*.

Two females, 23 and 34 mm.

Queensland: Cairns Reef, off Cooktown, 1905, coll. A. R. McCulloch; Michaelmas Cay, near Cairns, June, 1926, coll. G. P. Whitley and T. Iredale.

Previously recorded from W. Australia (Pocock, 1893; Balss, 1921) and Queensland (Hale, 1929*a*).

Gonodactylus glyptocercus Wood-Mason.

Gonodactylus glyptocercus Wood-Mason, *Proc. As. Soc. Bengal,* 1875, p. 232, reprinted in *Ann. Mag. Nat. Hist.* (4), XVII, 1876, p. 263; Kemp. *Mem. Ind. Mus.,* IV, 1, 1913, pp. 186-7; Bigelow, *Bull. Mus. Comp. Zool. Harv.,* LXXII, 4, 1931, pp. 136-9.

Protosquilla cerebralis Brooks, *Voy. H.M.S. "Challenger",* Zool., XVI, 1886, pp. 72-5, Pl. XIV, figs. 2, 3, Pl. XVI, figs 2, 3; Borradaile, *Proc. Zool. Soc.,* 1898, p. 33, Pl. V, fig. 6*a*.

Gonodactylus stoliurus McNeill, *Aust. Zoologist,* 4, 1926, fig. 2.

Two males, both 19 mm.; five females, 23-38 mm.

Queensland: Four specimens, Murray Is., 1907, coll. C. Hedley and A. R. McCulloch; two specimens, Michaelmas Cay, near Cairns, June 1926, coll. G. P. Whitley and T. Iredale; reef, North West Is., Capricorn Group, Dec. 1925, coll. G. P. Whitley.

Apparently common in coral in Queensland (McNeill, 1926; Stephenson, 1952, 1953*b*).

Gonodactylus stoliurus (Müller).

Gonodactylus trispinosus Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, p. 121 (*partem.*) and p. 460 (*fide* Pocock, *Ann. Mag. Nat. Hist.* (6), XI, 1893, p. 476).

Protosquilla stoliura Müller, *Verhand. Nat. Ges. Basel,* VIII, 1886, Pl. IV, fig. 2.

Gonodactylus stoliurus Ortmann, *Denk. Med. Wiss. Ges. Jena,* VIII, 1894, p. 61; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 184-5.

Female, 43 mm.

W. Australia: Lancelin Is., pres. Dr. D. L. Serventy.

Not previously recorded with certainty from Australian waters, but Pocock (1893) quotes Hansen's opinion that Miers' (1880 *b*) record of *G. trispinosus* from Sharks' Bay, W. Australia, refers to the present species.

The specimen, which was received too late (25th Sept., 1954) to be compared with Müller's description or figure, differs in the following minor respects from Kemp's description: (*a*) the cornea is very slightly wider than the eyestalk, (*b*) no serrations are apparent on the inner edge of the raptorial dactylus, (*c*) the median fissure of the telson extends roughly half-way up and there is an appreciable space between it and the median boss, (*d*) the lateral dorsal prominences of the sixth abdominal somite are not eroded, presumably because of less wear, and (*e*) the basal segments of the exopods of the uropods bear nine and ten spines on their outer sides, and not ten or eleven.

Hemisquilla stylifera (H. M. Edwards).

Gonodactylus styliferus H. Milne-Edwards, *Hist. Nat. Crust.,* II, 1837, p. 330, Pl. XXVII, figs. 9-14.

Pseudosquilla stylifera Miers, *Ann. Mag. Nat. Hist.* (5), V, 1880, p. 112; Kemp, *Mem. Ind. Mus.,* IV, 1, 1913, pp. 106-8, Pl. VII, figs. 84-85, fig. on p. 107.

Hemisquilla stylifera Schmitt, *Allan Hancock Pacific Exped.,* 5, 1940, pp. 182-3; Stephenson, *Mem. Q'ld. Mus.,* 13, 1, 1953, pp. 43-4.

Eleven males, 72-153 mm.; twelve females, 86-130 mm.

N.S. Wales: Off Clarence River, 12/ii/1920, pres. D. G. Stead (State Trawler "Brolga"); off Port Macquarie, 1922, pres. N.S. Wales State Fisheries, 30 fms., ejected from mouth of Flathead (fish) caught by line fishermen; two specimens, off Newcastle Bight ("Thetis" Expd., Stn. 21, 28-40 fms.), Aug. 1898, coll. E. R. Waite; off Newcastle, pres. A. D'Ombrain, trawled; 12 miles E. of Broken Bay, coll. H. Arnold, seine trawl; Rose Bay, Port Jackson, coll. H. Wright, alive within "blue groper fish", caught in prawn net; 15 miles off Port Jackson, 1936, pres. T. Wright, about 50 fms., hook and line; two specimens, 11-12 miles N.E. of Port Jackson, pres. M. Ward, 75 fms., steam trawler "Durimbee"; E. of Sydney, May 1920, pres. D. G. Stead, State Trawling Industry, 150 fms.; off Botany Bay, 1918, pres. D. G. Stead, 60 fms. (State Trawler "Gunundaal"); two specimens, off Cape Baily, near Botany Bay, 8/ix/1915, pres. D. G. Stead (State Trawler "Gunundaal"); mouth of Port Hacking, Aug. 1943, pres. K. Sheard, C.S.I.R. Fisheries Div., trawled about 50 m., *ex* stomach of Estuarine Flathead (fish); four specimens, off Wattamolla, near Port Hacking, 7/ii/1919, pres. D. G. Stead, State Trawling Industry, 68 fms.; off Burrewarra Point, near Batemans Bay, pres. Capt. K. Möller, trawled 50 fms.; about 18 miles S. of Montague Is., March 1927, pres. A. Ward, 50-60 fms., steam trawler "Bar-ea-mul"; off southern part of N.S. Wales coast, pres. Capt. K. Möller, trawled 40 fms.

Victoria: Bass Strait, pres. Common. Fish. Bur. (F.I.S. "Endeavour").

Recorded from near Tasmania (Hale, 1924), from Victoria (Kemp, 1913; Stephenson, 1952, 1954), and from N.S. Wales (Whitelegge, 1900). It is evidently common in moderately deep water off N.S. Wales.

The present specimens possess either one or two lobes between the submedian and intermediate spines of the telson and further invalidate Kemp's (1913) distinction between American and Australian "races".

III. Keys to the Australian Stomatopoda.

The only published keys to strictly Australian species are those of Hale (1927). These deal only with the southern species, which are a minority of the total fauna. The most comprehensive published keys are those of Kemp (1913) which deal with the entire Indo-Pacific fauna as known at that time. Kemp's keys are, on one hand, not comprehensive enough for modern use because they naturally exclude (*a*) indigenous species which have been discovered or segregated subsequently *viz., Squilla granti, S. depressa, S. mcneilli, S. terrareginensis, Lysiosquilla perpasta, L. vercoi, L. osculans* and *Gonodactylus tweediei,* and (*b*) more widespread species described subsequently which have been recorded from Australia (*e.g., S. anomala*). On the other hand Kemp's keys are possibly unnecessarily comprehensive in including forms which are not likely to be found in Australian waters.

The present keys are based upon Kemp, and include all known Australian and a selection from the non-Australian species. This selection includes species which are morphologically similar to Australian forms and should thereby assist the accurate identification of the latter. It also includes reasonable widespread Indo-Pacific forms which might be recorded from Australian waters when the northern shores are investigated more intensively. Non-Australian genera and species which are included in the keys are given within square brackets, and since they are not otherwise mentioned in the text, are accompanied by author and date. Descriptions, figures, and synonymy of non-Australian species described prior to 1913 are given in Kemp's monograph which should be referred to in all cases of suspected additions to the Australian fauna.

Throughout, when the number of teeth on the raptorial dactylus is given, the terminal tooth is included.

KEY TO GENERA.

1. Raptorial dactylus without teeth on its inner margin; *i.e.*, with only a terminal tooth 2
   Raptorial dactylus with teeth on its inner margin, in addition to a terminal tooth 3
2. (1) Raptorial dactylus basally inflated ..... *Gonodactylus*
   Raptorial dactylus not basally inflated ..... *Hemisquilla*†
   single Australian species *H. stylifera*.
3. (1) Raptorial dactylus basally inflated 4
   Raptorial dactylus not basally inflated 5
4. (3) General surface of telson closely studded with small spires or large tubercles .....
5. (3) Rostrum bifid ..... [*Coronidopsis* Hansen, 1926]
   General surface of telson (excluding carinae) smooth ..... *Odontodactylus*
5. (3) Rostrum bifid ..... [*Coronidopsis* Hansen, 1926]
   Rostrum entire 6
6. (5) First 5 abdominal somites with longitudinal carinae ..... *Squilla*
   First 5 abdominal somites without longitudinal carinae 7
7. (6) Body dorso-ventrally compressed, no distinct median carina on telson ..... *Lysiosquilla*
   Body laterally compressed, a distinct median carina on telson ..... *Pseudosquilla*

Genus **Squilla** Fabricius 1793.

KEY TO SPECIES.

1. Antennal somite very long; about thrice as long as broad ..... [*S. sibogae* Hansen, 1926]
   Antennal somite normal; about as long as broad 2
2. (1) Upper margin of propodus of raptorial claw with large well spaced spines alternating more or less regularly with more numerous, smaller spines (raptorial dactylus with nine, rarely eight teeth) 3
   Upper margin of propodus of raptorial claw with a series of fine and even pectinations in addition to a few movable spines at the proximal end 4
3. (2) Submedian carinae distinct on all abdominal somites, those on the 5th ending in spines; antennular peduncle fully as long as rostrum and carapace combined; ultimate segment of outer uropod jet-black with white midrib; lateral margin of 6th thosacic somite disinctly bilobed .....
   [*S. annandalei Kemp*, 1913.]
   Submedian carinae very faint except on the last abdominal somite, those on the 5th not ending in spines; antennular peduncle shorter than rostrum and carapace combined; ultimate segment of uropod lightly suffused with black on its inner longitudinal half only; lateral margin of 6th thoracic somite indistinctly bilobed ..... *S. raphidea*
4. (2) Lateral margin of 5th (first free) thoracic somite seen in dorsal view and composed of a single process, spinous or subacute 5
   Lateral margin of 5th thoracic somite seen in dorsal view and composed of two distinct processes; usually an anterior spine and rounded posterior lobe; rarely with 2 spines 23
5. (4) Cornea of eye very small, its breadth less than greatest breadth of stalk 6
   Cornea of eye small or large, its breadth always greater than greatest breadth of stalk 12
6. (5) First 5 abdominal somites with faint but distinct submedian carinae ..... [several spp.]
   First 5 abdominal somites without a trace of submedian carinae 7
7. (6) Anterolateral angles of carapace rounded ..... [*S. rotundicauda* (Miers, 1880)]
   Anterolateral angles of carapace spinous 8
8. (7) Breadth of cornea about ½ total length of eye ..... [*S. chlorida* Brooks, 1886]
   Breadth of cornea about 1/3 total length of eye 9
9. (8) Eye reaching 2/3 the length of the basal segment of the antennular peduncle .....
   [*S. microphthalma* H. M. Edw., 1837]
   Eye barely reaches to ½ the length of the basal segment of the antennular peduncle 10
10. (9) Mandibular palp absent ..... *S. granti*
    Mandibular palp present 11
11. (10) Eyestalks divergent from their bases ..... *S. depressa*
    Eyestalks apposed for most of their lengths ..... [*S. choprai* Tweedie, 1935]
12. (5) Numerous sharp longitudinal carinae on either side of median crest of telson 13
    No longitudinal carinae on either side of median crest of telson other than as thickenings of the marginal teeth 17
13. (12) Anterolateral angles of carapace spinous 14
    Anterolateral angles of carapace rounded 16
14. (13) Raptorial dactylus with 4 teeth; rostrum almost twice as long as broad .....
    [*S. ambigua* Hansen, 1926]
    Raptorial dactylus with 6 teeth; rostrum only slightly longer than broad 15
15. (14) Spines at the end of the submedian carinae of the telson non-movable; mandibular palp present .... *S. fasciata*
    Spines at the end of the submedian carinae of the telson movable; mandibular palp absent .... *S. fallax*
16. (13) Raptorial dactylus with 4 teeth; submedian carinae on first five abdominal segments .... *S. miles*
    Raptorial dactylus with 6 teeth; no submedian carinae on first five abdominal somites .....
    [*S. incerta* Hansen, 1926]
17. (12) Telson with long intermediate marginal teeth 18
    Telson with intermediate marginal teeth of normal length 19
18. (17) Raptorial dactylus with 4 teeth; mandibular palp absent ..... [2 spp.]
    Raptorial dactylus with 5 teeth; mandibular palp present ..... *S. mcneilli*
19. (17) Median carina of carapace absent .....
    [several spp. incl. *Sq. armata* H. Milne Edw., 1837 and *S. merguiensis* Tiwari & Biswas, 1952]
    Median carina of carapace present, with a clear bifurcation anteriorly ..... [2 spp.]
    Median carina of carapace present but not bifurcated anteriorly 20
20. (19) Mandibular palp present 21
    Mandibular palp absent 22
21. (20) 6 teeth on raptorial claw ..... [*S. bengalensis* Tiwari & Biswas, 1952]
    5 teeth on raptorial claw ..... *S. terrareginensis*
22. (20) Lateral process of 5th thoracic somite with a large black spot dorsally ..... *S. scorpio*
    Lateral process of 5th thoracic somite without a black dorsal spot .....[*S. immaculata* Kemp, 1913]
23. (4) First 5 abdominial somites each with more than 8 longitudinal carinae ..... [several spp.]
    First 5 abdominal somites each with 8 longitudinal carinae 24

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†The very occasional *monodactyla* forms of *Pseudosquilla* (Bigelow, 1931; Chopra, 1939) would segregate here.

24. (22) Lateral margin of 6th thoracic somite not bilobed 25
Lateral margin of 6th thoracic somite bilobed, the anterior lobe rarely small and inconspicuous 26

25. (24) Raptorial dactylus with 6 teeth; anterior bifurcation of median carina of carapace sharp and distinct .. *S. laevis*
Raptorial dactylus with 5 teeth; anterior bifurcation of median carina of carapace absent ..... [*S. hieroglyphica* Kemp, 1911]

26. (24) Raptorial dactylus with 5 teeth 27
Raptorial dactylus with 6 teeth 29
Raptorial dactylus with 7 or more teeth ..... [2 spp.]

27. (26) Rostrum with median carina; breadth of cornea more than 1/3 median length of carapace; lateral margin of 7th thoracic somite not bilobed ..... [*S. boops* Kemp, 1911]
Rostrum without median carina; breadth of cornea much less than 1/3 of median length of carapace; lateral margin of 7th thoracic somite distinctly bilobed 28

28. (27) Cornea set almost at right angles to eyestalk; outer inferior margin of raptorial merus terminating in a sharp tooth; anterior lobe of 7th thoracic somite short ..... *S. quinquedentata*
Cornea set obliquely on eyestalk; outer inferior margin of raptorial merus not terminating in a tooth; anterior lobe of 7th thoracic somite well developed and more than half as long as posterior lobe ..... [*S. gonypetes* Kemp, 1911]

29. (26) Cornea not wider than eyestalk; rostrum with short median carina; surface of carapace and abdomen with a coarse mesh-like reticulation ..... *S. foveolata*
Cornea very clearly wider than eyestalk; rostrum without median carina; surface of carapace and abdomen various, but not reticulated 30

30. (29) Cornea set almost at right angles to eyestalk 31
Cornea set obliquely on eyestalk 32

31. (30) Posterior half of median carina of carapace, anterior to cervical groove, simple; submedian carinae of 4th abdominal somite ending in spines ..... *S. nepa*
Posterior half of median carina of carapace, anterior to cervical groove, finely bicarinate throughout its entire length; submedian carinae of 4th abd. somite not ending in spines ....[*S. holoschista* Kemp, 1911]

32. (30) Lateral carinae of first 5 abd. somites bicarinate ..... [2 spp.]
Lateral carinae of first 5 abd. somites simple, not bicarinate 33

33. (32) Distinct rows of tubercles on either side of median crest of telson .... [*S. massavensis* Kossman, 1880]
No rows of tubercles on either side of median crest of telson 34

34. (33) Dorsal surface of carapace and abdomen smooth and highly polished; carapace broad, with its breadth behind the anterolateral angles more than half its median length, including the rostrum; anterior margin of ophthalmic somite with a minute median point ..... *S. wood-masoni*
Dorsal surface of carapace and abdomen rarely smooth, never highly polished; carapace narrow, with its breadth behind the anterolateral angles less than half its median length, including rostrum; anterior margin of ophthalmic somite various, but never with a minute point 35

35. (34) Median carina of carapace sharp and distinct throughout its course; dorsal carina of raptorial carpus with 3-5 tubercles ..... [2 spp.]
Median carina of carapace interrupted at base of anterior bifurcation (rarely, the anterior bifurcation is obsolete); dorsal carina of raptorial carpus with less than 3 tubercles 36

36. (35) Margin of longer spine of bifurcate process of uropods, in front of external lobe, convex; dorsal margin of raptorial carpus with 2 tubercles; eyes small ..... *S. interrupta*
Margin of longer spine of bifurcate process of uropods, in front of external lobe, concave 37

37. (36) Dorsal margin of raptorial carpus with 2 tubercles; eyes large . .... [*S. fabricii* Holthuis, 1941]
Dorsal margin of raptorial carpus with an entire carina 38

38. (37) Antennular peduncle long, over twice anterior breadth of carapace; distal segment of exopodite of uropod conspicuously divided into inner blackish and outer light coloured halves ..... *S. inornata*
Antennular peduncle short, considerably less than twice anterior breadth of carapace; distal segment of exopodite of uropod with a blackish suffusion near the base of the inner margin, but with the inner half never entirely blackish ..... *S. anomala*

Genus **Pseudosquilla** Dana 1852.

Key to Species.

1. Basal process of uropods terminating in 2 large teeth, its inner margin smooth 2
Basal process of uropods with a single large additional tooth or with a series on its inner margin 3

2. (1) Eyes short and flattened; cornea set transversely on stalk ..... [several spp.]
Eyes long and cylindrical; cornea set very obliquely on stalk ..... *P. ciliata*

3. (1) Raptorial dactylus with 3 teeth ..... [several spp.]
Raptorial dactylus with 4 teeth (submedian carinae of telson with 2 or 3 sharp spines, intermediate with 2 distal spines, first lateral with one) ..... *P. pilaensis*

Genus **Lysiosquilla** Dana 1852.

Key to Species.

1. Telson without a transverse row of dorsal spines near the hinder margin 2
Telson with a transverse row of dorsal spines near the hinder margin 6

2. (1) Hinder edge of telson deeply sculptured; raptorial dactylus with 5 teeth, rarely 6 ..... *L. perpasta*
Hinder edge of telson not deeply scultpured; raptorial dactylus with more than 7 teeth 3

3. (2) Shorter ramus of 6th and 7th thoracic limbs linear 4
Shorter ramus of 6th and 7th thoracic limbs broadly ovate 5

4. (3) Rostrum cordiform, at least as wide in front of the base as at the base, and not grooved near margin; raptorial dactylus of male with 10 or 11 teeth ..... *L. maculata*
Rostrum triangular, widest at base, with a deeply incised antero-lateral groove; raptorial dactylus of male with 8 teeth ..... *L. maculata* var. *sulcirostris* Kemp, 1913*

5. (3) Intermediate tooth of telson much smaller than lateral; raptorial dactylus with 10-21 teeth .. *L. vercoi*
Intermediate tooth of telson about the same size as the lateral; raptorial dactylus with 9 teeth. *L. osculans*

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* It seems doubtful if this variety is distinct from the *"forma typica"*.

6. (1) 3 dorsal spines in a transverse row on telson in adults ..... [*L. spinosa* Wood-Mason, 1875]
   5 dorsal spines in a transverse row on telson in adults 7
7. (6) Median spine on telson simple and acute 8
   Median spine on telson trilobed 11
8. (7) Telson with 4 pairs of large marginal teeth ..... [2 spp.]
   Telson with 3 pairs of large marginal teeth 9
9. (8) Penultimate tooth of raptorial dactylus longer than antepenultimate .....
   [*L. biminiensis pacificus* Borradaile, 1899]
   Penultimate tooth of raptorial dactylus much shorter than antepenultimate 10
10. (9) Raptorial dactylus with two lobes of about equal size at the base of the external margin .....
   L. acanthocarpus
   Raptorial dactylus with a very large distal and a small proximal lobe at the base of the external margin ..... *L. multifasciata*
11. (7) Rostrum more than 1½ times as long as broad; eyes large; a pair of posterior spines on the 6th abdominal somite in addition to those at the posterolateral angles ..... [*L. insignis* Kemp, 1911]
   Rostrum broader than long; eyes small; 6th abdominal somite with spines only at posterolateral angles ..... *L. latifrons*

Genus **Odontodactylus** Bigelow, 1894.

Key to Species.

1. Raptorial dactylus with at least 6 teeth on its inner margin 4
   Raptorial dactylus with 2-4 teeth on its inner margin 2
2. (1) 6th abdominal somite without carinae, and with 4 posterior spines; telson with only median carina ..
   [*O. elegans* Miers (1884) = juv. *O. scyllarus* (L. 1767); *fide* Hansen, 1926]
   6th abdominal somite with several carinae, six of them terminating posteriorly in spines; several carinae on either side of median crest of telson 3
3. (2) Basal segment of outer uropod shorter than ultimate, with 8 or 9 movable spines on outer edge ..... *O. cultrifer*
   Basal segment of outer uropod nearly twice as long as ultimate segment, with 11 or 12 movable spines on outer edge ..... *O. scyllarus*
4. (1) Telson with 2 pairs of submedian carinae and 2 pairs of laterals, the second lateral carina running to the apex of the lateral marginal tooth ..... *O. japonicus*
   Telson without the above characters ..... [several spp.]

Genus **Gonodactylus** Latreille 1825.

Key to Species.

1. Anterolateral angles of carapace well in advance of rostral base; basal segment of outer uropod extending at least a little beyond the insertion of the ultimate segment 2
   Anterolateral angles of carapace not in advance of rostral base; basal segment of outer uropod articulating terminally with ultimate segment 9
2. (1) Mandibular palp absent ..... [*G. acanthurus* Tattersall, 1900.]
   Mandibular palp present 3
3. (2) Inner uropod abnormal in shape, usually more or less crescentic in dorsal view or may be strongly arched in lateral view 4
   Inner uropod normal in shape 5
4. (3) Dorsal surface of telson with 9, possibly 11, sometimes closely packed keels .... *G. spinoso-carinatus*
   Dorsal surface of telson not possessing 9 closely packed keels ..... [several spp.]
5. (3) Mid-dorsal portion of telson with 5 long keels 6
   Mid-dorsal portion of telson with 3 long keels 7
6. (5) First 5 abdominal somites smooth ..... *G. falcatus*
   First 5 abdominal somites finely grooved transversely and longitudinally ..... *G. graphurus*
7. (5) Dorsal surface of telson never with spinules 8
   Dorsal surface of telson beset with spinules ..... *G. demani*
8. (7) No tubercles near the anterior margin of the telson; anterolateral angles of rostrum acute .....
   [*G. chiragra* var. *smithi** Pocock, 1893 = *G. acutirostris* de Man, 1898.]
   A pair of small tubercles close to the anterior margin of the telson; anterolateral angles of rostrum rounded or subacute ..... *G. chiragra*
9. (1) Distal margin of telson divided into right and left halves by a large, wide and deep incision 10
   Distal margin of telson divided by a long, very narrow median fissure with its edges partly in contact with one another 13
10. (9) Distal margin of telson with either 2 or 3 sharp teeth on either side of the incision .. [several spp.]
   Distal margin of telson with three blunt teeth on either side of the incision 11
11. (10) Dorsal surface of telson hairy ..... *G. tweediei*
   Dorsal surface of telson spiny 12
12. (11) Spines on telson recurved, with points directed backwards .....[*G. hystrix* Nobili, 1899.]
   Spines on telson not recurved backwards ..... [several spp.]
13. (9) Telson with 3 distinct bosses 14
   Telson without 3 distinct bosses, but with longitudinal furrows ..... [*G. hamifer* Odhner, 1923.]
14. (13) Of the three bosses in the centre of the telson, only the two external ones reach the middle of the telson 15
   Of the three bosses in the centre of the telson, the two external ones reach well beyond the middle of the telson 19
15. (14) Median portion of 5th abdominal somite entirely smooth 16
   Median portion of 5th abdominal somite wrinkled 18
16. (15) Rostrum sharply trispinous; dorsal process of ophthalmic somite produced into acute anterolateral corners 17
   Rostrum not sharply trispinous; dorsal process of ophthalmic somite not produced anterolaterally .....
   [*G. nefandus* Kemp, 1911.]

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* It is doubtful whether this variety deserves separate segregation (for "var. *platysoura*" see earlier).

17. (16) Telson with 3 elevated bosses bearing hairs ..... *G. pulchellus*
Telson with 2 or 3 longitudinal rounded ridges on either side of a central boss, the ridges being without setae ..... [*G. pulcher* Hansen, 1926.]

18. (15) Rostrum sharply trispinous; external bosses of telson with oval outline ..... *G. trispinosus*
Anterolateral angles of rostrum acute but not spinous; external bosses of telson circular in outline ..... [*G. tuberosus* Pocock, 1893.]

19. (14) 5th abdominal somite smooth mid-dorsally; 6th with six smooth rounded bosses .....
[*G. ectypus* Müller, 1886.]
5th and 6th abdominal somites grooved in a complicated manner ..... *G. glyptocercus.*
5th somite symmetrically grooved mid-dorsally. 6th with six dorsal bosses, each with five grooves running towards the summit ..... *G. stoliurus.*

IV. Summary and Discussion.

Kemp's monograph (1913) lists sixteen species of Stomatopoda from Australia. Later work has shown that one of these (*Lysiosquilla miersi*) is relegated to the synonymy. Of another two, one (*Squilla microphthalma*) has become established under the name *S. depressa,* and one (*S. armata*) has proved to be a wrongly determined record based on a species (*S. mcneilli*) which has since been recognized as new to science. The total of species recorded from Australian seas has been considerably increased since Kemp's time. This has resulted from published works by Hale (1924, 1927, 1929*a, b*); McNeill (1926, 1952); Serène (1950, 1952); and Stephenson (1952, 1953*a, b,* 1954). A total of forty-one species is now recognized, including the possibly doubtful records of *Squilla scorpio* and *Odontodactylus japonicus,* and excluding the discredited var. *platysoma* of *Gonodactylus chiragra.* This is roughly one-third of the known species of Stomatopoda from the Indian Ocean and West-Pacific Ocean waters.

TABLE 1.

Distribution of Australian stomatopods in the various Australian States; possible doubtful records are indicated by a ?.

Species.	N.T.	Q'ld.	N.S.W.	Vict.	Tas.	S. Aust.	W. Aust.
Squilla raphidea	+	+		...	...	...	...
S. granti	...	+	...	...	...	...	...
S. depressa	...	+	...	...	...	...	...
S. fasciata	...	+	...	...	...	+	...
S. fallax	...	...	+	...	...	...	...
S. miles	...	...	...	...	+	+	+
S. mcneilli	...	...	+	...	...	...	...
S. scorpio	?	...	...	...	...	...	...
S. terrareginensis	...	+	...	...	...	...	...
S. laevis	...	+	+	+	...	+	+
S. quinquedentata	+	+	...	...	...	...	...
S. foveolata	...	+	...	...	...	...	...
S. nepa	...	+	...	...	...	...	...
S. wood-masoni	+	+	...	...	...	..	+
S. interrupta	...	+	+	...	...	...	...
S. inornata	+	+	...	...	...	+	...
S. anomala	...	+	...	...	...	...	...
Pseudosquilla ciliata	...	+	...	...	...	...	...
P. pilaensis	...	+	...	...	...	...	...
Lysiosquilla perpasta	...	+	+	+	+	+	...
L. maculata	...	+	+	...	...	...	+
L. vercoi	...	+	+	+	+	+	...
L. osculans	...	...	...	+	...	+	...
L. acanthocarpus	+	...	...	...	...	...	...
L. multifasciata	...	+	...	...	...	...	...
L. latifrons	...	...	+	...	...	...	...
Odontodactylus cultrifer	...	+	...	...	...	...	...
O. scyllarus	...	+	...	...	...	...	...
O. japonicus	...	...	...	...	...	...	?
Gonodactylus spinoso-carinatus	...	+	...	...	...	...	...
G. falcatus	...	+	...	...	...	...	+
G. graphurus	+	+	...	...	...	...	+
G. demani	...	+	...	...	...	...	...
G. chiragra (incl. var. *platysoma*)	+	+	...	...	...	...	+
G. tweediei	...	+	...	...	...	...	...
G. pulchellus	...	+	...	...	...	...	...
G. trispinosus	...	+	...	...	...	...	+
G. glyptocercus	...	+	...	...	...	...	...
G. stoliurus	...	...	...	...	...	...	+
Hemisquilla stylifera	...	...	+	+	+	...	...
Totals	9	30	11	6	4	7	10

The distribution of stomatopod species as summarized in Table I excludes those occurring at Lord Howe Island, located 300 miles east of N.S. Wales. A noticeable feature of the summary is the relative paucity of the faunas of the southern Australian States of Victoria, Tasmania and South Australia. The total stomatopod fauna of southern Australian seas amounts to only eight species. Of these, one (*Hemisquilla stylifera*) is more Pacific Ocean in its distribution than Indo-Pacific or Indo-West-Pacific (Ekman, 1953, pp. 11 *et. seq.*). Its range extends across the mid-Pacific "boundary" to the west coasts of both the North American and South American continents, but the species does not occur in the Indian Ocean. Two others (*Squilla fasciata* and *S. inornata*) are Indo-Pacific species and are apparently far from common in southern Australian waters; each has been recorded only once, from South Australia (Tate, 1883). The remaining five southern Australian species (*S. miles, S. laevis, Lysiosquilla perpasta, L. vercoi* and *L. osculans*) have been recorded only from Australia, and never from its tropical waters. *Squilla miles* and *S. laevis* are common and conspicuous forms, and it seems unlikely that, if they occurred either in the East Indies or in New Zealand, they would have been overlooked. The same argument is more strongly exemplified with the three cited species of *Lysiosquilla*. Therefore it seems legitimate, *pro tem.*, to regard all the five forms as indigenous cold water species, isolated from the main assemblage of the Indo-Pacific stomatopod fauna. As a corollary it seems likely either that they have evolved in an area of semi-isolation (tantamount to a region of speciation) or that they are relict species. The former alternative seems more probable because of the absence of any indications of morphological primitiveness, and in view of a somewhat parallel situation in east South African waters. Here the only indigenous species is the cold water *Lysiosquilla capensis* Hansen, 1895 (see Barnard, 1950, pp. 856-858).

The five distinctive species of the waters of the south-eastern quarter of Australia, plus the wider Pacific Ocean species, *Hemisquilla stylifera,* provide the evidence that three-quarters of the fauna of this region is not, in the strict sense, made up of Indo-Pacific forms. It therefore seems doubtful whether S.E. Australia can be included in the Indo-Pacific area from the aspect of stomatopod biogeography. This applies with greatest force to Tasmania and Victoria, from the waters of which no truly Indo-Pacific species have yet been recorded. The particular region involved in this argument corresponds roughly to the Maugean cold temperate province of Australia proposed by Iredale and May (1916) in their mollusc studies, and later modified by Bennett and Pope (1953) in their work on the common zoning forms of rocky shores. This province is geographically different from Kott's (1952) concept of the Maugean in her tunicate studies.

The stomatopod fauna occurring within the Maugean province extends considerably beyond the limits as defined by previous workers. Thus three of five species in question range north-westward into either the Flindersian province of South Australian waters (see Cotton, 1938; Clark, 1946; Kott, 1952; Bennett and Pope, 1953) or westward to a Baudinian region (Kott, 1952) in far south-western Australia, within the Flindersian province. This diffuse distribution is in contrast with other marine groups such as the molluscs (Hedley, 1904; Iredale, 1914, 1924; Ashby, 1926; Allan, 1950); the echinoderms (Clark, 1938, 1946); and the tunicates (Kott, 1952). Another difference is that south-western Australia is the focus of indigenous species in some groups (*e.g.*, echinoderms—Clark, 1946), while south-eastern Australia is the focus in the stomatopods.

Apart from the species of southern Australian waters, there appear to be five indigenous stomatopods. One (*Squilla mcneilli*) has a limited distribution midway between southern and northern parts, and occurs off the New South Wales coast. Its known distribution is probably limited by the extent of offshore trawl fishing. The remainder (four) occur in the more northerly waters of Australia. Two of them are from such restricted localities that their biogeographical affinities are unknown. These are *Squilla granti* from Moreton Bay, Queensland and *S. terrareginensis* from near Cairns, Queensland. The other two species are *S. depressa* and *Gonodactylus tweediei.* The first of these is known from eastern Queensland and the N. Territory, and is one of the numerous links between the faunas of those widely separated parts. The second has been recorded only from the Capricorn Group, Queensland and from Lord Howe Island, east of N.S. Wales, and is discussed here later.

Of the non-indigenous species, one (*Lysiosquilla latifrons* from New South Wales) is a cold water form recorded also from New Zealand and Japan (see Kemp, 1913). Another is *Hemisquilla stylifera,* from south-eastern Australian waters, including N.S. Wales and, as shown earlier, widely distributed in the south Pacific Ocean. Ekman (1953, p. 196) considered that *Sq. armata* was another non-indigenous cold water form but his comments are unfounded, as previously shown in the systematic section of this study (see *S. mcneilli*).

The remaining non-indigenous species, which dominate the overall picture of Australia's stomatopod fauna, are widespread, warm water, Indo-West-Pacific forms. These constitute the following fractions of the faunas of the various States of Australia: N. Territory, $-\frac{8}{9}$; Queensland, $-\frac{23}{30}$; N.S. Wales, $-\frac{5}{11}$; Victoria, $-\frac{0}{6}$; Tasmania, $-\frac{0}{4}$; Sth. Australia, $-\frac{2}{7}$; West Australia, $-\frac{8}{10}$. The dominance of Indo-Pacific species is proportionately greatest in the N. Territory, but numerically greatest in Queensland. This numerical predominance of Queensland is almost certainly due to more intensive collecting in that State. It seems highly probable that, with the same sort of intensive collecting in the N. Territory, additional widespread Indo-Pacific species will be found. Much the same argument applies to the northern coasts of Western Australia.

Comparison between the stomatopod faunas of the N. Territory and Queensland shows that, of the eight species firmly recorded from the former, seven occur also in Queensland waters, while the eighth (*Lysiosquilla acanthocarpus*) is known in all from only twenty-three specimens collected over a very widespread area, and can be regarded as a chance rarity. The N. Territory and Queensland species (particularly those of North Queensland waters) must be regarded as belonging to a biogeographic entity, which would also embrace species from the north of Western Australia. Stomatopod distribution provides no evidence to support the theory that northern Australia comprises two distinctive biogeographical provinces—Solanderian and Dampierian. These were postulated for the molluscs (Hedley, 1904, 1926) and proved satisfactory for the echinoderms (Clark, 1946). The same provinces are retained for the dominant fauna of rocky shores (Bennett and Pope, 1953), although recent work (Endean, Kenny and Stephenson in MS.) tends to the opposite conclusion.

From north to south, the numbers of Indo-West-Pacific species decline on both the eastern and western coasts of Australia. Material from the western quarter is too fragmentary for detailed consideration, but critical data on that from the eastern coasts are given in Table 2.

TABLE 2.

Southerly limits of warm water Indo-Pacific species on the East Coast of Australia, excluding Lord Howe Island. Latitudes are given to the nearest 30′.

Species.	Locality.	Lat. South.
Gonodactylus pulchellus	Princess Charlotte Bay	14° 30′
G. trispinosus	Michaelmas Cay, Cairns	16° 30′
G. demani	Green Is., Cairns	16° 30′
Lysiosquilla acanthocarpus	Dunk Is.	18° 0′
Squilla quinquedentata	Townsville	19° 0′
S. nepa	Townsville	19° 0′
S. foveolata	Townsville	19° 0′
Pseudosquilla pilaensis	Bowen	20° 0′
G. spinoso-carinatus	Capricorn Group	23° 30′
G. glyptocercus	Capricorn Group	23° 30′
G. graphurus	Great Sandy Strait	25° 30′
Odontodactylus scyllarus	Noosaville	26° 30′
S. fasciata	Moreton Bay	27° 30′
S. anomala	Moreton Bay	27° 30′
P. ciliata	Moreton Bay	27° 30′
O. cultrifer	Moreton Bay	27° 30″
G. falcatus	Moreton Bay	27° 30′
G. chiragra	Moreton Bay	27° 30′
L. maculata	Port Jackson	34° 0′
S. raphidea	Port Jackson	34° 0′
S. wood-masoni	Port Jackson	34° 0′
S. interrupta	Port Jackson	34° 0′
S. fallax	Port Jackson	34° 0′

The main discontinuity in stomatopod distribution is in southern Queensland. This area has been collected more intensively than any other parts of the Australian waters. It is possible that the concentration of limits is a reflection of the collecting intensity, although it seems more probable that the discontinuity is a real one. Three of the species involved are *Squilla anomala, S. fasciata* and *Odontodactylus cultrifer,* which occur fairly commonly in catches of penaeid (commercial) prawns from Moreton Bay (27° 30′ S); they are accompanied by the species, *S. laevis.* From the next prawning grounds southward, in N.S. Wales waters (Evans Head, 29° S), a large collection of stomatopods was especially made by Mr. Lane, Fisheries Inspector. It contained only *S. laevis,* and this suggested that the other three species just mentioned must certainly be much rarer there than in Moreton Bay. Another two species involved (*Gonodactylus falcatus* and *G. chiragra*) decline markedly in abundance from tropical to sub-tropical Queensland, and their relative sparsity in Moreton Bay indicates that this locality is very near to their southern limit of distribution. If it is concluded that these stomatopod distribution limits are substantial, Moreton Bay could be accepted as the most likely boundary of tropical dominance in the fauna. This is much further north than Ekman (1952, p. 25) suggested in his "Zoogeography of the Sea". Ekman's boundary has already been criticised by Bennett and Pope (1953) as being ". . . . . too far to the south, and most other authors on biogeography to whose work reference has been made, agree."

Unfortunately the habitats of many of the Australian specimens are unknown. It is difficult, for example, to segregate the coral dwelling species. These include many species of *Gonodactylus,* and one would expect their limits of distribution to terminate with the southern extent of coral formations. Two species (*G. spinoso-carinatus* and *G. glyptocercus*) certainly do stop at the Capricorn Group of cay islets at the southern limits of the Great Barrier Reef, while two more (*G. falcatus* and *G. tweediei*) extend

to the most southerly coral formation—Lord Howe Island (31° S). The affinities of stomatopod fauna of this isolated area, if such can be deduced from so sparse a fauna, are definitely with southern Queensland, rather than with the more adjacent N.S. Wales waters, as is also the case with the echinoderms (see Endean, 1953).

Without a more detailed knowledge of habitats, and of exact localities in some cases, it is impossible to segregate a Banksian or coral reef fauna (see Whitley, 1932) from a Solanderian or mainland coastal fauna in Queensland waters. Present indications are that the species of *Squilla* dominate the coastal region, where the habitat is characterized by shallow silted to muddy waters. On the other hand, species of *Gonodactylus* dominate the offshore coral reef area (Banksian), especially in coral breccia, but some are also recovered from dredgings in the shallow inshore water, and occur in the coastal inter-tidal zone under stones.

Apart from the distribution discontinuity in southern Queensland, the only remaining one of note is in the waters of Port Jackson and near vicinity, N.S. Wales (34° S). One suspects that this is again an apparent effect due to high intensity of collecting. The four widespread species involved here are *Squilla raphidea, S. wood-masoni, S. interrupta* and *Lysiosquilla maculata.* These are evidently amongst the most cold tolerant of the warmer water Indo-Pacific forms. The remainder of the N.S. Wales fauna consists of the indigenous cooler water species *S. laevis, L. perpasta* and *L. vercoi,* plus a miscellany including the widespread Pacific species *Hemisquilla stylifera,* a cold water Indo-Pacific species, *Lysiosquilla latifrons,* and a species, *S. mcneilli,* indigenous to local waters. This mixture of faunistic compounds has insufficient homogeneity to justify the acceptance of a Peronian province for the Stomatopoda (see Hedley, 1926; Clark, 1946; Bennett and Pope, 1953; Endean, 1953).

Summarizing the biogeography of the Australian stomatopods, it is that (1) There are two main elements—(*a*) an indigenous cold water fauna centred in the waters of the south-eastern quarter, with some species extending to Western Australia and southern Queensland, and (*b*) a much larger Indo-West-Pacific fauna dominating the northern waters, with the limit of dominance on the eastern Queensland coast at about the region of Moreton Bay, and with western limits unknown; (2) these two elements overlap in N.S. Wales, resulting in a fauna of mixed relationships; the same condition possibly holds for South Australia and the southern waters of Western Australia; and (3) the various faunistic provinces or regions recognized by workers in other spheres (*viz.* Solanderian, Banksian, Peronian, Maugean, Flindersian and Baudinian) are inappropriate to the present context.

Acknowledgments.

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The following work arrived in the mail while proofs of the present contribution were being read.—Serène, R., 1954.—Observations Biol. sur les Stomatopodes. *Mém. de L'Inst. Océanographique de Nhatrang*, Se Mém., pp. 1-93, Pls. 1-10, text figs. 1-15 and map.

The work is primarily biological, without systematic approach to the species dealt with. Several of the specific names, however, are not in agreement with those recorded by us (*e.g.*, *Squilla oratoria*, var. *inornata* and *Gonodactylus platysoma*) but we are fully satisfied about the designations of our various specimens.

Another two works which must be added to the bibliography have also been located. These are.—

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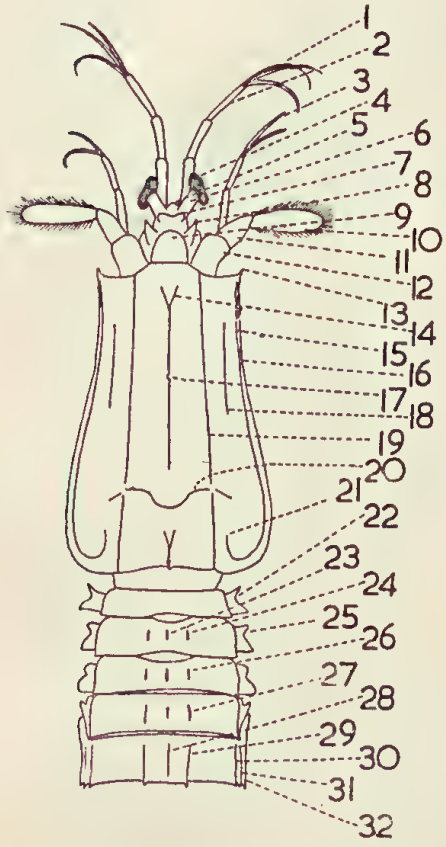
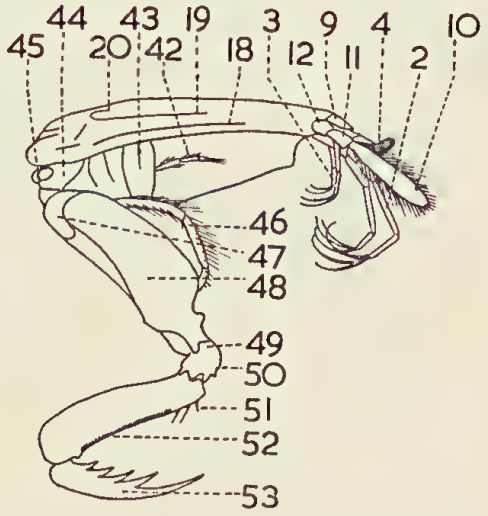
Explanation of Figure 1.

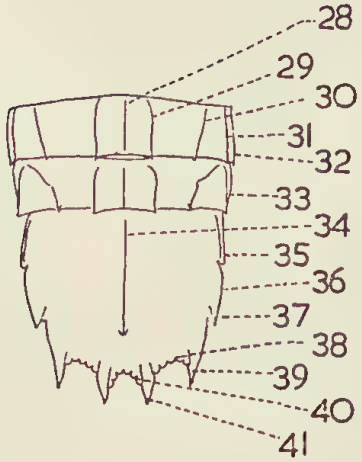
1, flagellum of antennule (1st antenna); 2, peduncle of antennule (1st antenna); 3, flagellum of endopodite of antenna (2nd antenna); 4, cornea; 5, tip of ophthalmic somite; 6, eyestalk; 7, antennular somite; 8, dorso-lateral processes of antennular somite; 9, rostrum; 10-12, antenna (10, scale (distal exopodite); 11, proximal segment of exopodite; 12, basal segment); 13-21, carapace (13, anterolateral angle (here spinous); 14, anterior bifurcation of median carina; 15, lateral carina; 16, marginal carina; 17, median carina, position of small pit; 18, intermediate carina; 19, gastric groove; 20, cervical groove; 21, posterior reflected part of marginal carina); 22-27, thoracic somites; (22, lateral processes of 5th (first free); 23, median carina of 6th; 24, submedian carina of 6th; 25, lateral processes of 6th; 26, submedian carina of 7th; 27, submedian carina of 8th); 28-32, 1st and 5th abdominal somites respectively (28 median carina; 29, submedian carina; 30, intermediate carina; 31, lateral carina; 32, marginal carina); 33, convergence of lateral and marginal carinae of 6th abdominal somite; 34-41, telson (34, median carina; 35, prelateral lobe or denticle; 36, lateral tooth; 37, lateral denticles; 38, intermediate denticles; 39, intermediate tooth; 40, submedian denticle; 41, submedian tooth); 42, mandibular palp; 43, mandible; 44, protopodite of raptorial claw; 45, epipodites of raptorial claw; 46, first thoracic appendage; 47-53, raptorial claw (47, ischium; 48, merus; 49, carpus; 50, carina of carpus; 51, movable spines of propodus; 52, immovable spines on upper margin of propodus; 53, dactylus); 54-61, uropod (54, basal segment; 55, bifurcated process of basal segment; 56, proximal segment of exopodite; 57, spines on edge of proximal segment; 58, large spine at end of proximal segment; 59, distal segment of exopodite; 60, endopodite; 61, denticles or teeth on inner side of basal process); 62, swelling on longer of two bifurcated processes, here bordering a concave proximal region; 63, tip of longer bifurcated process; 64, tip of shorter bifurcated process.

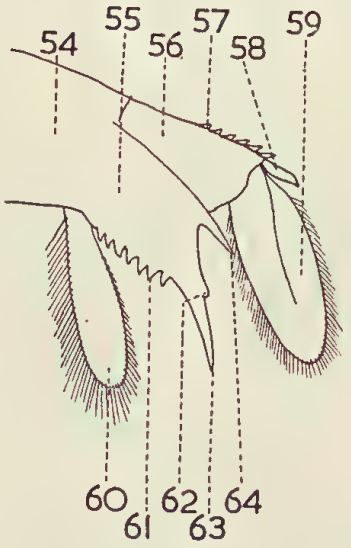
Figure 1.

Diagram showing terminology of external features of Stomatopoda with (*a*) dorsal view of head, thorax and first abdominal somite, (*b*) lateral view of head and carapace regions, with thoracic appendages deflected ventrally, (*c*) dorsal view of last two abdominal somites and telson, (*d*) ventral view of left uropod on a larger scale.









THE NEW SOUTH WALES CANCELLARIIDAE*

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(Figures 1-13.)

Introduction.

Hedley in his Check List in 1918 recorded six species of this family as occurring in New South Wales. Since that time considerable revision in nomenclature has taken place, and some further material has come to hand. As descriptions and references to the family are very scattered in literature, the opportunity is now taken to bring them together, and to illustrate not only species new to science, but also all those which have already been described. It is felt that such papers are of great convenience to conchologists and form a base on which future work can be undertaken. The complete check list of species from the Peronian zoogeographical province will now read as follows:

Sydaphera renovata Iredale
„ *obnixa* Iredale
„ *anxifer* Iredale
„ *delicosa* Laseron
„ *scobina* Hedley
Trigonaphera vinnula Iredale
„ *interlaevis* Laseron.
Arizelostoma laseroni Iredale
Pepta stricta Iredale
Microsveltia recessa Iredale
Pallidonia simplex Laseron.

All types, as well as specimens illustrated, are being presented to the Australian Museum, Sydney.

Description of Species.

Genus **Sydaphera** Iredale, 1929.

Genotype, *Sydaphera renovata* Iredale.

Beyond designating the genotype Iredale gives no generic description. The separation of this group from the European *Cancellaria* is justified, however, inasmuch as *Cancellaria* proper has a narrow umbilicus while *Sydaphera* is imperforate, and in *Cancellaria* the spiral sculpture is much stronger, producing a cancellate surface. The general form of the shell is similar.

Sydaphera renovata Iredale.

(Figs. 1, 1*a*, 2.)

Australian Zoologist, v, 1929, p. 341.

This is the common Sydney Harbour shell listed as *Cancellaria australis* Sowerby, No. 802 in Hedley's Check List. In the synonymy of this species, May in 1923 considered that *C. undulata* Sowerby should replace *australis*, and other conchologists have since concurred in this nomenclature. Iredale, when proposing his genus *Sydaphera*, also separated the New South Wales species from *undulata*, the type of which came from Tasmania, remarking that the Sydney shell was larger, narrower, and with fewer and broader transverse ribs. More important differences than this, however, lie in the protoconch and sculpture. The protoconch of *undulata*

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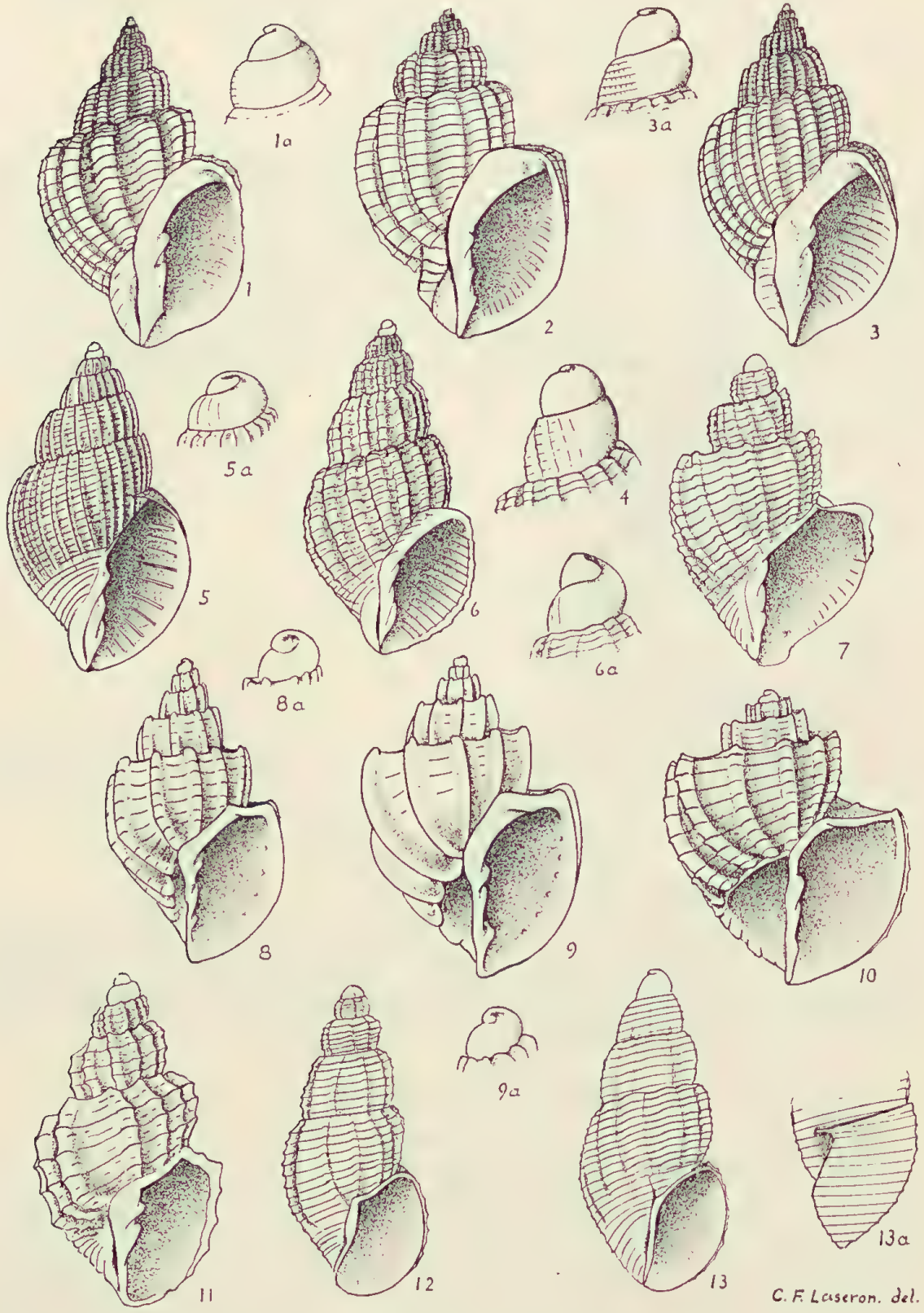

Figures 1 to 13.

1, 2, *Sydaphera renovata* Iredale (1*a*, protoconch); 3, *Sydaphera obnixa* Iredale (3*a*, protoconch); 4, *Sydaphera undulata* Sowerby, protoconch; 5, *Sydaphera delicosa* Laseron (5*a*, protoconch); 6, *Sydaphera anzifer* Iredale (6*a*, protoconch); 7, *Sydaphera scobina* Hedley and Petterd (after Hedley); 8, *Trigonaphera vinnula* Iredale (8*a*, protoconch); 9, *Trigonaphera interlaevis* Laseron (9*a*, protoconch); 10, *Arizelostoma laseroni* Iredale; 11, *Microsveltia recessa* Iredale; 12, *Pepta stricta* Hedley; 13, *Pallidonia simplex* Laseron (13*a*, sinus).

is more than twice the size of that of *renovata,* its length being 2 mm. while that of *renovata* is less than 1 mm. The spiral sculpture of *undulata* is also much stronger, consisting of well defined ribs instead of narrow threads as in *renovata.* For comparison the protoconch of a North Tasmanian speciment of *undulata* is here shown (Fig. 4). As the protoconch of *renovata* has not yet been figured this is also shown (Fig. 1*a*). Sydney specimens of *renovata* vary slightly, some being comparatively broader. Figure 1 is from 6 fathoms in Sydney Harbour, its length 31 mm. Figure 2 is an exceptionally large and broad specimen from Cronulla 46 mm. in length. Specimens have also been taken alive well out on the continental shelf in from 30-35 fathoms off Crookhaven.

Sydaphera obnixa Iredale.

(Figs. 3, 3*a*.)

Rec. Aust. Mus., xix, 1936, p. 318, Pl. xxiii, fig. 6.

Iredale separated *obnixa* from *renovata* as having a greater number of transverse ribs and by the coloration, *obnixa* having narrow brown spiral bands, while *renovata* is uniformly creamy-white. Each form has its distinct geographical range, *obnixa* being confined to the north coast of New South Wales, while *renovata* lives from Sydney southwards. There is some doubt as to whether the difference between the two forms is fully specific or merely racial. Specimens have been seen suggesting that the two converge towards each other, but as a rule there is little difficulty in recognizing them, though worn specimens are apt to be confusing. It has been noticed that, in older specimens of *obnixa,* the ribs may become almost obsolete on the last half of the body whorl. The protoconch is very similar, identical in size, but the initial whorl of *obnixa* is relatively a little larger. The specimen figured is from Forster, its length 39 mm.; the protoconch is from a young specimen collected by Miss Thornley from Angowrie.

Sydaphera delicosa sp. nov.

(Figs. 5, 5*a*.)

Shell relatively small, conical, spire elevated, creamy-white. Protoconch small, about one mm. in length, summit rather flat, nucleus cup-shaped, rapidly expanding, incipient sculpture appearing gradually on the second whorl. Adult whorls four, rounded, restricted at the sutures, slightly flattened below them. Sculpture primarily axial, consisting of numerous narrow, rounded ribs, about 24 to the whorl, fading on the base. The spiral sculpture is fine, consisting of numerous threads, which override the transverse ribs, but not strongly enough to produce a cancellation. Aperture with a thin rounded outer margin, lirate within, peristome incomplete, practically no callus on the inner margin, columella straight, imperforate, flattened at the anterior end, with a slight hollow but no umbilicus, columella folds three, the posterior nearly transverse, the median one oblique, the anterior one slight. Length 24 mm., width 11 mm., aperture 13 mm.

Locality.—Woolgoolga.

Remarks.—This is by far the most finely sculptured of the local species, and it cannot be readily confused with any other.

Sydaphera anxifer Iredale.

(Fig. 6, 6*a*.)

Rec. Aust. Mus., xiv, 1925, p. 264, Pl. xliii, fig. 24.

Closely allied to the Tasmanian species *purpuriformis* Kuster, from which it differs by its larger size, more robust shell and by being lirate within the aperture. The specimen figured is from 30-35 fathoms off Crookhaven, and is 30 mm. in length; the protoconch is from an immature specimen collected by Miss Thornley from Port

Stephens. This species is easily recognized by its long narrow spire and the short aperture, only about two-fifths of the total length. Together with the Tasmanian *purpuriformis* it seems closely linked with a group of fossil species, notably *Cancellaria exaltata* Tate and *C. epidromiformis* Tate from the Muddy Creek Beds (Miocene) of Victoria.

Sydaphera scobina Hedley and Petterd.

(Fig. 7, after Hedley.)

Rec. Aust. Mus., vi, 1906, p. 222, Pl. 38, fig. 12.

A deep-water species, the type came from 300 fathoms east of Sydney, and was only 8 mm. in length. Its systematic position has been considered doubtful, as Hedley in the following year reduced it to a varietal form of the Tertiary fossil *Cancellaria micra* Tate, and in his Check List placed it under the genus *Admete*. Iredale in 1924 considered it should be restored to *Cancellaria*. The type, however, may not be mature, as it has only three instead of the usual four whorls, and the aperture does not seem fully formed. The sculpture, the straight columella with three folds, and the lack of an umbilicus all suggest *Sydaphera*, and with another whorl it would probably fall typically into this genus.

Genus **Trigonaphera** Iredale, 1936.

Genotype. *Trigonostoma vinnulum* Iredale, Rec. Aust. Mus., xix, 1936, p. 319.

The use of *Trigonostoma* for this and various Queensland shells is certainly untenable, for the genotype *Trigonostoma trigonostoma* is a unique South African species quite unlike any other known. *Trigonaphera* forms a natural group having a sub-trigonal aperture, straight columella with three folds, turreted shells with strong transverse ribs and faint spiral sculpture, and with a deep umbilicus penetrating the axis of the shell.

Trigonaphera vinnula Iredale.

(Figs. 8, 8*a*.)

Rec. Aust. Mus., xiv, 1925, p. 263, Pl. xliii, fig. 18.

This replaces *Cancellaria antiquata* Hinds, No. 801 in Hedley's Check List. *C. antiquata* was recorded from Sydney Harbour by Angus in 1877, but numerous specimens which have since come to hand show that it only superficially resembles the type which came from New Guinea. The specimen is one of a series from 30-35 fathoms off Crookhaven, its length 16 mm. The protoconch (Fig. 8*a*) is here figured for the first time. It consists of 1½ whorls, with a minute nucleus, set rather obliquely to the main axis of the shell.

Trigonaphera interlaevis, sp. nov.

(Figs. 9, 9*a*.)

Shell broadly turreted, white or cream (may be faded). Protoconch naticoid, 1½ whorls, the nucleus small, slightly oblique. Mature whorls four, turreted, excavated above the periphery making a hollowed shelf to the sutures. Sculpture strongly transverse, consisting of strong raised rounded ribs, about 10 to the whorl, separated by flat intercostal spaces about twice the width of the ribs. The ribs continue over the sharp angle of the periphery to the suture, dividing the hollowed shelf into rounded compartments. The ribs continue on to the base, fusing as they bend into the deep umbilicus. Spiral sculpture is almost entirely absent, and is only visible under the lens as very faint threads. Aperture sub-trigonal, outer and upper margin corresponding to the form of the last transverse rib, narrowed anteriorly, inner margin straight, reflected to overhang the umbilicus and to form a thick layer of callus on the body whorl, columella straight and narrow with three prominent folds, the centre one oblique, umbilicus broad and deep. Length 14 mm., breadth 9 mm.

Localities.—Port Stephens (type); specimen in Australian Museum, C.10646, collected by C. Hedley; a number of specimens from the beach at Woolgoolga.

Remarks.—This is evidently the species recorded in the Check List, No. 803, as *Cancellaria costifera* Sowerby. There has always been uncertainty as to the identity of this species in New South Wales. When Angas recorded it in 1877 he spoke of it as a dwarf variety, and the type itself is labelled as *C. costifera* var. A specimen of what may be the true *costifera* from the Queensland coast differs chiefly in its more pronounced spiral sculpture and by being strongly lirate within the aperture. Compared with *T. vinnula, interlaevis* is broader, with rounded instead of straight sides, a broader umbilicus, and fainter spiral sculpture.

Genus **Arizelostoma** Iredale, 1936.

Genotype, *Arizelostoma laseroni* Iredale.

Arizelostoma may be looked upon as an extreme form of *Trigonaphera* in which the spire is further depressed so that the earlier whorls are partly hidden behind the angulated periphery of the whorls, the transverse ribs are fused together on the base forming a bar surrounding the extremely wide rounded umbilicus, and the triangular mouth is more exaggerated. The aperture is also almost free, only a short portion being reflected back and attached to the body whorl. Justification of the separation generically of *Arizelostoma* from *Trigonaphera* will depend largely on the individual view of conchologists as to what constitutes true genetic values.

Arizelostoma laseroni Iredale.

(Fig. 10.)

Rec. Aust. Mus., xix, 1936, p. 318, Pl. xxiv, fig. 9.

The type locality is Shellharbour, where specimens are occasionally washed up on the beach. The specimen figured is, however, from Point Halliday, its length 17 mm., and width 14 mm. It is a very striking species, though rare, and cannot be readily confused with any other on the coast.

Genus **Microsveltia** Iredale, 1925.

Genotype, *Microsveltia recessa* Iredale.

Shell small, broadly conical, sculpture of strong axial ribs crossed by spiral threads, aperture subtriangular, columella with two plaits only, a slight umbilical chink. In general form it resembles *Sydaphera*, but is much smaller, and it also has only two columella plaits instead of three.

Microsveltia recessa Iredale.

(Fig. 11.)

Rec. Aust. Mus., xiv, 1925, p. 265, Pl. xliii, fig. 16.

The figure is drawn from the type in the Australian Museum which came from 75 fathoms, off Bateman's Bay. Its length is 6 mm., and width 3.5 mm. This is similar to, but not the same as, *Cancellaria exigua* Smith, described from 410 fathoms, off Port Jackson. This is the disputed station of the "Challenger" Expedition, where a number of species from the North Atlantic were recorded as off the New South Wales coast. *C. exigua* should, I think, be removed from the New South Wales list.

Genus **Pepta** Iredale, 1925.

Genotype, *Admete stricta* Hedley.

Shell small, narrowly ovate, protoconch of a single dome-shaped whorl, sculpture of undulating axial ribs overridden by spiral cords, aperture short and rounded, the columella with a single broad fold behind which is a narrow umbilical chink. The classification is uncertain, but as the limited material conforms generally to other members of the Cancellaridae it may provisionally be retained in that family.

Pepta stricta Hedley.

(Fig. 12, after Hedley.)

Hedley, *Admete stricta,* Rec. Aust. Mus., vi, 1907, p. 295, Pl. 54, fig. 10.

The type locality is 80 fathoms, off Narrabeen, the dimensions given being length 4.5 mm., width 1.76 mm.

Genus **Pallidonia,** gen. nov.

Genotype, *Pallidonia simplex* Laseron.

A small genus of uncertain classification with an ovate shell, few whorls, simple dome-shaped protoconch, weak axial but stronger spiral sculpture consisting of regular evenly spaced cords, aperture short and rounded, outer margin simple but with a wide subsutural sinus, no anterior canal, columella without a fold but slightly flexed, behind it a narrow umbilical chink.

The systematic position of this genus is very doubtful, and it is only placed provisionally in the Cancellariidae because of its general resemblance to *Pepta stricta,* and because there is no other family in which it will satisfactorily fit. The wide posterior sinus alone suggests the Turridae, but the absence of an anterior canal precludes that family. In some ways it resembles *Lironoba* in the Rissoidae, but again the sinus prevents its inclusion there. It is quite possible it represents a new family, and relationship may be sought in the Australian Tertiary rather than elsewhere.

Pallidonia simplex, sp. nov.

(Figs. 13, 13*a*.)

Shell small, elongate-ovate, white. Protoconch rather worn, but short, a minute apical whorl, the next whorl apparently smooth. Remaining whorls three, rounded, sutures impressed, not excavate at the base, body whorl more than half the length. Sculpture of weak, broad, rounded axial ribs, about 10 to the whorl, overridden by strong rounded cords with narrow interstices, seven on the penultimate whorl, about 15 on the body whorl, persisting to the base. Aperture short and rounded, outer margin thin, with a broad subsutural sinus with a sloping shoulder, broadly rounded anteriorly, and no anterior canal. Inner margin nearly straight and only slightly flexed, the columnella smooth with a callus continuing to complete the peristome, a slight smear of callus on the body whorl above. Behind the columella is a narrow umbilical chink. Length 3.9 mm., width 1.7 mm.

Locality.—Dredged 8-10 fathoms, off Point Halliday.

Remarks.—The only Peronian species with which this can be compared is *Pepta stricta* Hedley, from which it differs by the weaker axial and stronger more rounded spiral cords, by the absence of a fold on the columella, and of course by the sinus in the outer margin.

THE FOOD OF TROUT IN NEW SOUTH WALES*

1938-1940.

By (THE LATE) KEITH C. MCKEOWN.

STOMACH CONTENTS OF BROWN TROUT.

(*Salmo eriox* Linne.)

Delegate River.

No. 1.—? sex, Weight 1¾ lb. ; Length, 16 in. ; Date, 2/March, 1940 ; Time, 7 p.m. ; Fly : Royal Coachman. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : 1 large Anisopterid dragonfly (red), 2 stick Caddis cases, 1 winged Ant (*Iridomyrmex*).

No. 2.—? sex, 1½ lb. ; 15½ in. ; 12/March, 1940 ; 6 p.m. ; Fly : Teal and Red. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : 1 large Anisopterid dragonfly (red).

No. 3.—? sex, ¾ lb. ; 13¾ in. ; 18/March, 1940; 6.15 p.m. ; Fly : Teal and Red. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : very small quantity finely divided and unidentifiable insect remains.

No. 4.—? sex, 1 lb. ; 13½ in. ; 20/March, 1940; Fly : Teal and Red. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : 1 beetle (*Bolboceras* sp.), 1 beetle (? *Tenebrionidae*) remains, remains of moth, 1 sand Caddis case.

No. 5.—? sex, 1¾ lb. ; 15 in. ; 23/April, 1940; Time ? ; Fly : Black Gnat. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : empty.

No. 6.—? sex, ¾ lb. ; 13½ in. ; 23/April, 1940; Time ? ; Fly : Black Gnat. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : 2,300 winged ants (*Iridomyrmex*), 3 small Scarabaeid beetles.

No. 7.—? sex, 3 lb. 3 oz. ; 22 in. ; 24/April, 1940; 5.15 p.m. ; Fly : Bugong Moth No. 4. Collected by Mr. Boyce C. Dent, from Monaro District Acclimatisation Society, Cooma. Contents : 1 grasshopper (? gen. et sp.), 2 stick Caddis cases, remains of winged ants.

Kydra River.

No. 8.—Sex ♀; 1 lb. ; 28/October, 1939; 6 p.m. ; Fly : Red West. Collected by Mr. J. D. Gaden, from Monaro District Acclimatisation Society, Cooma. Contents : 1 Pentatomid bug (remains), 1 *Heteronyx*, small quantity insect remains, charcoal dust.

No. 9.—Sex ♀; 2 lb. ; 2/December, 1939; 2.45 p.m. ; Fly : Red Ant. Collected by Mr. W. T. Brady (?), from Monaro District Acclimatisation Society, Cooma. Contents : 3 *Diphucephala* sp., 5 *Heteronyx* sp., 2 grasshoppers (? sp. immature), 2 stick Caddis cases, 3 sand Caddis cases, quantity finely divided insect remains.

No. 10.—Sex ♀; 1 lb. ; 2/December, 1939; 4.45 p.m. ; Fly : Smart's Red-tail. Collected by Mr. W. J. Forbes, from Monaro District Acclimatisation Society, Cooma. Contents : empty.

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* This continuation of the series of papers on the Food of Trout was arranged for publication by Mr. G. P. Whitley, from notes left by Mr. McKeown. The previous paper appeared in REC. AUST. MUSEUM, xx, 1, 1937 : 38.

Fish River, Tarana.

No. 11.—? sex, ¾ lb.; Length ?; 24/December, 1938; Time p.m; Fly: Black Spinner. *Note*: water low, weather hot and clear. Collected by Mr. Les. Richards. Contents: 4 Cicadas (*Psaltoda moerens*), 1 grasshopper (immature).

No. 12.—? sex, ½ lb.; Length ?; 24/December, 1938; Time p.m.; Fly: Black Spinner. Collected by Mr. Les. Richards. Contents: 1 Crayfish (*Parachaeraps bicarinatus*), remains of grasshoppers.

No. 13.—? sex, ½ lb.; Length ? ; 24/December, 1938; Time p.m.; Fly: Black Spinner. *Note*: water low, weather hot and clear. Collected by Mr. Les. Richards. Contents: remains of unidentifiable beetle.

No. 14.—? sex, ¾ lb.; 13 in.; 25/December, 1938; noon; Fly: Black Spinner. *Note*: fine and hot. Collected by Mr. Les. Richards. Contents: 5 Cicadas (*Psaltoda moerens*) and remains of others.

No. 15.—Sex ♀; ½ lb.; 12 in.; 25/December, 1938; noon; Fly: Black Spinner. Collected by Mr. E. G. Garrett. Contents: 1 Cicada (*Psaltoda moerens*).

No. 16.—Sex ♀; ¾ lb.; 12½ in.; 26/December, 1938; noon; Fly: Red Tag Palmer. *Note*: weather fine and hot. Collected by Mr. E. G. Garrett. Contents: 2 grasshoppers (immature), remains of one large unidentifiable beetle.

No. 17.—Sex ♀; ½ lb.; 11 in.; 26/December, 1938; noon; Fly: Red Tag Palmer. Collected by Mr. E. G. Garrett. Contents: 1 Anisopterid nymph, remains of Pentatomid bug, 3 *Gerris*.

No. 18.—Sex ♀; ¾ lb.; 12 in.; 26/December, 1938; 12.30 p.m.; Fly: Red Palmer *Note*: weather hot and clear, water clear and low. Collected by Mr. E. G. Garrett. Contents: 7 Grasshoppers (*Chortoicetes terminifera*), 1 Cicada (*Psaltoda moerens*).

No. 19.—Sex ♀; ½ lb.; 12 in.; 30/January, 1939; 4 p.m.; Fly: Black Spinner. *Note*: very low water. Collected by Mr. E. G. Garrett. Contents: 41 winged ants (*Iridomyrmex*), 23 *Gerris* sp., fragments of bark.

No. 20.—Sex ♀; 9 oz.; 13 in.; 30/January, 1939; 5 p.m.; Fly: "Clyde". *Note*: very low water. Collected by Mr. E. G. Garrett. Contents: 4 grasshoppers (immature), 3 Asilid flies (*Blepharotes coriarius*), remains of dragonflies, 1 beetle (*Aphodius* sp.).

No. 21.—? sex; Weight ?; Length ?; 19/February, 1939; Time a.m.; Fly: Hopper Hackle. Collected by Mr. E. G. Garrett. Contents: 1 large *Onthophagus* sp., 1 *Paropsis* sp., leg of grasshopper.

No. 22.—Sex ♂; ½ lb.; 7/April, 1939; noon; Fly: Cocky bundhu. Collected by Mr. E. G. Garrett. Contents: 7 waterboatmen, 1 aquatic larva (? ? ?).

No. 23.—? sex, 10 oz.; 12 in.; 7/April, 1939; Fly: Cocky bundhu. *Note*: water flowing well after recent rain—weather cold and cloudy. Collected by Mr. E. G. Garrett. Contents: empty.

No. 24.—? sex, ½ lb.; 12 in.; 7/April, 1939; Time ?; Fly: Coachman. Collected by Mr. W. Rowan Lowry. Contents: 1 Sugar Ant (*Camponotus*), 3 winged ants (*Iridomyrmex*), 3 sand Caddis cases, remains of beetle, small quantity insect remains.

No. 25.—Sex ♂; ¾ lb.; 12½ in.; 7/April, 1939; Time ?; Fly: Coachman. Collected by Mr. W. Rowan Lowry. Contents: 1 large Crayfish (*Parachaeraps bicarinatus*).

No. 26.—Sex ♀ (full roe); 10 oz.; 12 in.; 23/April, 1939; 3 p.m.; Fly: Hardy's Favourite. Collected by Mr. E. G. Garrett. *Note*: water clear, weather dull and cold. Contents: 1 Pumpkin beetle (*Aulacophora oliveri*), 73 *Gasteruption* sp. (a truly remarkable find !), 6 *Oechalia schellenbergii*, quantity of insect remains.

Sachwall's Creek, Tarana.

No. 27.—? sex; ½ lb.; 10 in.; 7/November, 1938; 10 a.m.; Fly: "Washwood" (? Dashwood). Collected by Mr. E. G. Garrett. *Note*: moderately clear—good flow—weather showery and cloudy at intervals. Abundant insect life along banks. Contents: 2 sand Caddis cases.

STOMACH CONTENTS OF LOCH LEVEN TROUT.

(*Salmo levenenis* Walker.)

Kydra River.

No. 1.—Sex ♂; 1 lb.; 2/December, 1939; 2.45 pm.; Fly: Smart's Red-tail. Collected by Mr. W. J. Forbes, from Monaro District Acclimatisation Society, Cooma. Contents: 3 *Heteronyx* sp., 2 Clickbeetles (*Conoderus*), 1 stick Caddis case. 4 Dryopidae, quantity coarse gravel.

No. 2.—Sex ♂; 1½ lb.; 2/December, 1939; 3.15 p.m.; Fly: Smart's Red-tail. Collected by Mr. W. J. Forbes, from Monaro District Acclimatisation Society, Cooma. Contents: empty.

Big River.

No. 3.—Sex ♂; 2 lb.; 30/April, 1940; 3.5 p.m. Collected by Mr. S. N. McLean, Snowy Waters, Bungarby, from Monaro District Acclimatisation Society, Cooma. Contents: 372 winged ants (*Iridomyrmex*), 1 grasshopper (immature), 1 stick Caddis case, 5 *Heteronyx* sp.

STOMACH CONTENTS OF RAINBOW TROUT.

(*Salmo irideus* Gibbons.)

Kybean River.

No. 1.—Sex ♀; 4 lb.; 21 in.; 30/December, 1938; 4 p.m. Collected by Mr. F. W. Barrett. Contents: 5 stick Caddis cases (large), 52 sand Caddis cases.

No. 2.—Sex ♀; 1¾ lb.; Length ?; 3/January, 1939; 5.30 p.m. Collected by Mr. A. Barrett. Contents: 245 Caddis cases (sand).

No. 3.—Sex ♀; 3 lb.; Length ?; January, 1939; 5 p.m. Collected by Mr. P. W. Barrett. Contents: empty.

No. 4.—Sex ♀; 1¼ lb.; Length ?; January, 1939; 7 p.m. Collected by Mr. Pfeiffer. Contents: Algae and vegetable matter.

No. 5.—Sex ♀; 1¼ lb.; Length ?; January, 1939; Time ?. Collected by Mr. Alwyn Barrett. Contents: 2 stick Caddis cases.

No. 6.—Sex ♀; 1½ lb.; 8/November, 1939; 3 p.m. Collected by Mr. F. C. Gaden, from Monaro District Acclimatisation Society, Cooma. Contents: 132 Caddis cases (sand), 18 Mayflies, 1 *Gerris*, 1 Caddis fly (adult), quantity broken insect remains.

MacLaughlin River.

No. 7.—Sex ♂; 4 lb.; Length ?; 3/January, 1939; 7 p.m. Collected by Mr. Alwyn Barrett. Contents: Remains of Mayflies.

No. 8.—Sex ♂; 3¾ lb.; Length ?; 3/January, 1939; 7 p.m. Collected by Mr. Alwyn Barrett. Contents: 1 winged ant, 2 Mayfly nymphs, 1 *Gerris*.

No. 9.—Sex ♀; 4 lb.; Length ?; 3/January, 1939; 7.15 pm. Collected by Mr. Alwyn Barrett. Contents: 1 stick Caddis case.

No. 10.—Sex ♂; 3¼ lb.; Length ?; 3/January, 1939; 7.15 p.m.; Fly: Loch Orde. Collected by Mr. L. Barrett. Contents: empty.

No. 11.—Sex ♀; 4 lb.; 20½ in.; 4/January, 1939; 12.5 p.m. Collected by Mr. F. W. Barrett. Contents: 1 *Corixa* (immature), wings of Mayflies.

No. 12.—Sex ♂; 5¼ lb.; 22½ in.; 4/January, 1939; 3.50 p.m. Collected by Dr. A. Glen. Contents: empty.

No. 13.—Sex ♀; 1 lb. 11 oz.; 16 in.; 4/January, 1939; 6.30 p.m. Collected by Mr. Alwyn Barrett. Contents: 2 Anisopterid nymphs, 1 stick Caddis case, 7 small Dytiscid beetles.

No. 14.—Sex ♀; 3 lb.; 1/October, 1939; 5.15 p.m.; Fly: Red Ant. Collected by Mr. J. D. Gaden, from Monaro District Acclimatisation Society, Cooma. Contents: 12 small Dytiscids (yellow and brown ⅛ in.,) 2 stick Caddis cases.

No. 15.—Sex ♀; 4 lb.; 3/November, 1939; 5 p.m.; Fly: Jungle Cock. Collected by Mr. J. D. Gaden, from Monaro District Acclimatisation Society, Cooma. Contents: 1 waterboatman, 23 small water beetles (Dytiscidae) (brown and yellow ⅓ in.), 2 remains of coleopterous larvae, 1 large Hydrophyllid larva, 1 Mayfly, remains of large beetles, quantity of Algae.

Big River.

No. 16.—Sex ♂; 1½ lb.; 30/April, 1940; 3.5 p.m. Collected by Mr. S. M. McLean. Snowy Waters, Bungarby, from Monaro District Acclimatisation Society, Cooma, Contents: 83 winged ants (*Iridomyrmex*), remains of *Onthophagus* (several specimens).

Fish River, Tarana.

No. 17.—Sex ♀; ½ lb.; 12 in.; 30/January, 1939; noon; Fly: Guinea. *Note*: very low water. Collected by Mr. E. G. Garrett. Contents: 59 *Gerris*, elytron of large water beetle (Dytiscidae) green with yellow margin, remains of Pentatomid bug.

No. 18.—? sex; Weight ?; 12 in.; 19/February, 1939; noon; Fly: Hopper Hackle. Collected by Mr. E. G. Garrett. Contents: 2 grasshoppers (immature).

No. 19.—? sex; Weight ?; 10 in.; 7/April, 1939; 2 p.m. Collected by Mr. E. G. Garrett. Contents: 1 *Onthophagus* sp., 1 grasshopper (immature), 1 waterboatman.

Goodradigbee River, Brindabella.

No. 20.—Sex ♀; 12 oz.; 13¼ in.; (No. 24) 7/April, 1939; Time ?; Fly: ?. Collected by Mr. J. Dowling. Contents: 4 Hydrophyllid larvae, 9 chitinous Caddis cases.

No. 21.—Sex ♂; 9 oz.; 12¾ in.; (No. 25) 7/April, 1939; Time ?; Fly: ?. Collected by Mr. John Dowling. Contents: 5 Hydrophyllid larvae, 53 *Gerris* sp., 9 Caddis cases (chitinous), 1 Elaterid (? gen. et sp.), remains of tree-grasshopper (Tettigonidae).

No. 22.—Sex ♀; 13 oz.; 13½ in.; (No. 26) 8/April, 1939; 11 a.m.; Fly: Red Wasp. Collected by Mr. John Dowling. Contents: mud.

No. 23.—Sex ♀; 8 oz.; 11 in.; (No. 27) 8/April, 1939; noon; Fly: Coachman. Collected by Mr. W. H. Dowling. Contents: 8 sand Caddis cases, 1 spider (*Epeira* sp.), 1 ant (? gen. et sp.).

No. 24.—Sex ♀; 10 oz.; 11¾ in.; (No. 29) 8/April, 1939; 5 p.m.; Fly: Red Wasp. Collected by Mr. John Dowling. Contents: 2 large Anisopterid nymphs, 2 Hydrophyllid larvae, quantity of mud.

No. 25.—Sex ♀; 1 lb. 2 oz.; 13½ in.; (No. 28) 8/April, 1939; 6 p.m.; Fly: Professor. Collected by Mr. J. R. Gibson. Contents: 11 sand Caddis cases, 1 grasshopper (immature), 1 gordian worm, 2 Mayflies.

No. 26.—Sex ♀; 1 lb. 5 oz.; 14¾ in.; (No. 30) 10/April, 1939; 5.30 a.m. Collected by Mr. H. Tindale. Contents: 1 large Huntsman Spider ♂ (*Isopeda immanis*), unidentifiable remains of insects chiefly Coleoptera.

No. 27.—Sex ♀; 1 lb. 2 oz.; 15 in.; (No. 31) 23/April, 1939; Time ?; Fly: Coachman. Collected by Mr. W. H. Dowling. Contents: 9 sand Caddis cases, 1 Anisopterid nymph.

No. 28.—Sex ♂; 9 oz.; 12 in.; (No. 32) 23/April, 1939; Time ?; Fly: Coachman. Collected by Mr. W. H. Dowling. Contents: 137 Caddis cases (spiral, sand), 3 Caddis cases (sand), 3 Mayfly nymphs.

No. 29.—Sex ♀; 9 oz.; 12 in.; (No. 33) 23/April, 1939; Time ?; Fly: Coachman. Collected by Mr. W. H. Dowling. Contents: 9 large Anisopterid nymphs, 1 large Hydrophyllid larva, 3 sand Caddis cases.

No. 30.—? sex; 12 oz.; 13¼ in.; (No. 201) 18/November, 1939; 3 p.m.; Fly: Cocky. Collected by Mr. V. C. Bennett. Contents: 3 Bugong moths, quantity insect remains.

No. 31.—? sex; 8 oz.; 9¼ in. (injured); (No. 202) 18/November, 1939; Time ?; Fly: Cocky. Collected by Mr. V. C. Bennett. Contents: 8 chitinous Caddis cases, 5 sand Caddis cases, mud.

No. 32.—Sex ♀; 10 oz.; 12 in.; (No. 203) 19/November, 1939; 6 p.m.; Fly: Coachman. Collected by Mr. W. H. Dowling. Contents: 13 chitinous Caddis cases, quantity of vegetable matter.

No. 33.—Sex ♂; 16 oz.; 13 in.; (No. 204) 20/November, 1939; Time ?; Fly: Cocky. Collected by Mr. G. S. Stogdale. Contents: 137 chitinous Caddis cases, quantity of mud.

No. 34.—Sex ♀; 11 oz.; 12 in.; (No. 205) 20/November, 1939; 11.30 a.m; Fly: Coachman. Collected by Mr. W. H. Dowling. Contents: 17 Bugong moths, 47 sand Caddis cases, quantity of mud.

No. 35.—Sex ♂; 12 oz.; 12 in.; (No. 206) 23/November, 1939; Time ?; Fly: Cocky. Collected by Mr. V. C. Bennett. Contents: 24 chitinous Caddis cases, 1 Anisopterid nymph.

No. 36.—Sex ♂; 12 oz.; 12½ in. (No. 208) 24/November, 1939; Time ?; Fly: Ginger Hackle. Collected by Mrs. W. P. Bluett, Koorabri, Brindabella. Contents: 1 stick Caddis case, 63 chitinous Caddis cases, quantity broken insect remains.

No. 37.—Sex ♀; 12 oz.; 12½ in.; (No. 209) 10/December, 1939; Time ?; Fly: Blue and Black. Collected by Mrs. W. P. Bluett. Contents: 11 chitinous Caddis cases, 1 Chrysomelid beetle, 2 *Gerris*, quantity of mud.

No. 38.—Sex ♀; 15 oz.; 13½ in.; (No. 210) 16/December, 1939; 6 p.m.; Fly: Coachman Collected by Mr. H. P. Bluett. Contents: Stomach crammed with Algae.

No. 39.—Sex ♂; 20 oz.; 15 in.; (No. 212) 23/December, 1939; noon; Fly: Greenwell's Glory. Collected by Mr. V. H. Freeth. Contents: Stomach crammed with remains of Bugong moths, 1 Hydrophyllid larva, 2 Elaterid beetles, quantity of mud.

No. 40.—Sex ♀; 21 oz.; 15½ in.; (No. 211) 23/December, 1939; noon; Fly: Greenwell's Glory. Collected by Mr. V. H. Freeth. Contents: 32 *Phyllotocus navicularis* (Scarab), 1 *Paropsis* sp., quantity of Algae, 1 Longicorn beetle (*Phoracantha*).

No. 41.—Sex ♀; 1 lb. 12 oz.; 15½ in.; (No. 213) 23/December, 1939; 7 p.m.; Fly: Silver Doctor. Collected by Mr. V. H. Freeth. Contents: 4 *Diphucephala* sp., 2 *Phyllotocus navicularis*, large quantity of Algae.

No. 42.—Sex ♀; 1 lb. 13 oz.; 16¼ in.; (No. 214) 24/December, 1939; Time ?; Fly: Pevril of the Peak. Collected by Mr. V. H. Freeth. Contents: Stomach crammed with remains of hundreds of Bugong moths.

No. 43.—Sex ♀; 16 oz.; 14 in.; (No. 215) 24/December, 1939; 10 a.m.; Fly: Red Tag. Collected by Mr V. H. Freeth. Contents: 2 Bugong moths, stomach crammed with remains.

No. 44.—Sex ♀; 20 oz.; 14 in.; (No. 216) 25/December, 1936 (? 9); 10.30 p.m.; Fly: Red Tag. Collected by Dr. Temple Smith. Contents: quantity of Algae, skin of a wild berry, quantity of mud.

No. 45.—Sex ?; 20 oz.; 14½ in.; (No. 217) 26/December, 1939; 5.45 p.m.; Fly: Cocky. Collected by Mr. V. C. Bennett. Contents: bones of frog (small).

No. 46.—Sex ♀; 32 oz.; 17 in.; (No. 218) 27/December, 1939; 11 a.m.; Fly: ?. *Note*: 82°. Collected by Mr. W. H. Dowling. Contents: 1 Anisopterid nymph, remains of cicada, 3 Bugong moths and remains, large quantity Algae, large quantity mud.

No. 47.—Sex ?; 44 oz.; 19 in.; (No. 219) 27/December, 1939; 6.30 p.m.; Fly: Silver Doctor. Collected by Mr. V. H. Freeth. Contents: 4 *Psaltoda moerens* (Cicada), 1 large Anisopterid nymph, bones of frog.

No. 48.—Sex ♀; 24 oz.; 15½ in.; (No. 220) 28/December, 1939; 4.30 p.m.; Fly: Cocky. *Note*: hot, 86°. Collected by Mr. W. H. Dowling. Contents: 3 Cicadas (*Psaltoda moerens*), 1 Bugong moth, 1 Scarabaeid (? gen. et sp.) (green, large).

No. 49.—Sex ♀; 28 oz.; 16¼ in.; (No. 221) 1/January, 1940; 7 a.m.; Fly: Coachman. Collected by Mr. V. H. Freeth. Contents: 1 Bugong moth, remains of Cicada.

No. 50.—Sex ♀; 56 oz.; 20½ in.; (No. 222) 22/January, 1940; 2.15 p.m.; Fly: Red Tag. Collected by Mr. H. P. Berne. Contents: Algae.

No. 51.—Sex ♀; 44 oz.; 19½ in.; (No. 223) 26/January, 1940; 3 p.m.; Fly: Professor. Collected by Mr. A. Berne. Contents: 1 Crayfish (*Parachaeraps bicarinatus*), quantity of Algae.

No. 52.—Sex ♀; 4 lb. 2 oz.; 22 in.; (No. 224) 30/January, 1940; 7.30 p.m.; Fly: Black Hackle. Collected by Mr. E. Dickson. Contents: sand, unidentifiable animal remains (? frog).

No. 53.—Sex ♀; 24 oz.; 15½ in.; (No. 251) 27/February, 1940; 3 p.m.; Fly: Ginger Hackle. Collected by Mr. J. T. Wheeler. Contents: quantity of mud.

No. 54.—Sex ♀; 24 oz.; 16 in.; (No. 252) 27/February, 1940; 6 p.m.; Fly: Ginger Hackle Collected by Mr. J. T. Wheeler. Contents: empty.

No. 55.—Sex ♂; 26 oz.; 15½ in.; (No. 253) 29/February. 1940; 1.30 p.m.; Fly: Ginger Hackle. Collected by Mr. J. T. Wheeler. Contents: quantity of Algae.

No. 56.—Sex ♀; 22 oz.; 15¾ in.; (No. 254) 29/February, 1940; 2.20 p.m.; Fly: Ginger Hackle. Collected by Mr. J. T. Wheeler. Contents: Remains of wasp (unidentifiable), quantity of Algae.

No. 57.—Sex ♂; 36 oz.; 19 in.; (No. 255) 2/March, 1940; Time ?; Fly: Royal Coachman. Collected by Mr. R. O. Pomroy. Contents: empty.

No. 58.—Sex ♀; 18 oz.; 14 in.; (No. 256) 3/March, 1940; 1 p.m.; Fly: Red Lochordie. Collected by Mr. W. Southwell. Contents: remains of beetle (unidentifiable), quantity of Algae, fragments of bark.

No. 59.—Sex ♂; 14 oz.; 12½ in.; (No. 257) 7/March, 1940; Time ?; Fly: Cocky. Collected by Mr. H. K. McPherson. Contents: 6 Bugong moths, remains of Praying Manti (? *Archimantis*).

No. 60.—Sex ♀; 24 oz.; 16 in.; (No. 260) 16/March, 1940; 5 p.m.; Fly: Hopper Hackle. Collected by Mr. H. E. Taplin. Contents: 1 Anisopterid Dragonfly, 1 Ichneumon wasp.

No. 61.—Sex ♀; 12 oz.; 13 in.; (No. 258) 17/March, 1940; Time ?; Fly: Hopper Hackle. Collected by Mr. H. E. Taplin. Contents: 2 stick Caddis cases, 1 Anisopterid nymph, 1 feather, quantity of Algae.

No. 62.—Sex ♂; 8 oz.; 12 in.; (No. 259) 17/March, 1940; 11.30 a.m.; Fly: opper Hackle. Collected by Mr. H. E. Taplin. Contents: 5 Bugong moths, 1 sugar ant, small quantity of remains.

No. 63.—Sex ♀; 1 lb. 3 oz.; 14 in.; (No. 261) 19/March, 1940; 6.30 p.m.; Fly: White Moth. Collected by Mr. W. Southwell. Contents: 2 stick Caddis cases, 1 Bugong moth, 1 grasshopper (immature), 32 *Gerris* sp.

No. 64.—Sex ♂; 12 oz.; 12¼ in.; (No. 263) 20/March, 1940; 11 a.m.; Fly: Ginger Quill. Collected by Mr. V. H. Freeth. Contents: Quantity of Algae.

No. 65.—Sex ♂; 16 oz.; 13¾ in.; (No. 262) 20/March, 1940; 12 noon; Fly: Ginger Quill. Collected by Mr. V. H. Freeth. Contents: 1 large Anisopterid Dragonfly, 1 small Dytiscid beetle, quantity of Algae.

No. 66.—Sex ♀; 11 oz.; 12 in.; (No. 264) 20/March, 1940; 12.30 p.m.; Fly: Ginger Quill. Collected by Mr. V. H. Freeth. Contents: 1 large Hydrophyllid larva, 2 winged ants (*Iridomyrmex*).

No. 67.—Sex ♂; 20 oz.; 15 in.; (No. 265) 20/March, 1940; 5 p.m.; Fly: Caddis nymph. Collected by Mr. W. H. Dowling. Contents: 3 Bugong moths.

No. 68.—Sex ♀; 16 oz.; 14½ in.; (No. 266) 22/March, 1940; 11 a.m.; Fly: March Brown. Collected by Dr. Temple Smith. Contents: 1 grasshopper (immature), 1 Chrysomelid beetle, 1 Tenebrionid beetle (*Pterohelaeus*), quantity of Algae.

No. 69.—Sex ♂; 20 oz.; 14¼ in.; (No. 267) 22/March, 1940; 11.30 a m.; Fly: Nymph. *Note*: warm and still, much flannel weed. Contents: 1 Blackfish (*Gadopsis marmoratus* Richardson, 1848), and remains of another River Blackfish or "Slippery", a small common, native freshwater fish of no economic importance.

No. 70.—Sex ♀; 31 oz.; 17 in.; (No. 268) 22/March, 1940; 11.30 a.m.; Fly: Ginger Quill. Collected by Mr. V. H. Freeth. Contents: 27 Bugong moths, many fine threadworms, quantity of mud.

No. 71.—Sex ♀; 38 oz.; 18 in.; (No. 269) 22/March, 1940; 3.30 p.m.; Fly: Lochordie. Collected by Mr. W. Southwell. Contents: 1 Crayfish (*Parac aeraps bicarinatus*), 1 large Anisopterid nymph, 1 Bugong moth, 1 wasp (Scoliid), 1 Dytiscid larva, 1 grasshopper (immature).

No. 72.—Sex ♀; 21 oz.; 15½ in.; (No. 270) 22/March, 1940; 6 p.m.; Fly: Lochordie. Collected by Mr. W. Southwell. Contents: 1 fish (*Gadopsis marmoratus* Richardson, 1848), River Blackfish or "Slippery", a small, common, native freshwater fish of no economic importance.

No. 73.—Sex ♀; 20 oz.; 16 in.; (No. 271) 23/March, 1940; 11.30 a.m.; Fly: Cocky. *Note*: warm, 82°, no wind, few rising. Collected by Mr. W. H. Dowling. Contents. 1 Diamond beetle (*Chrysolophus spectabilis*), 1 stick Caddis case, quantity of Algae:

No. 74.—Sex ♂; 46 oz.; 20½ in.; (No. 272) 24/March, 1940; 2.30 p.m.; Fly: Royal Coachman. Collected by Mr. V. H. Freeth. *Note*: hot, light wind, 86°. Fish rising freely. Contents: 1 Diamond beetle (*Chrysolophus spectabilis*), 5 Noctuid moths (unidentifiable), 1 grasshopper (*Gastrimargus musicus*), 1 large *Heteronyx* (?), wings of stone fly, large quantity of broken insect remains (wings ? Lepidoptera), quantity of Algae.

No. 75.—Sex ♀; 18 oz.; 14 in.; (No. 273) 24/March, 1940; 3 p.m.; Fly: Royal Coachman. Collected by Mr. V. H. Freeth. *Note*: hot and still. Contents: 5 winged ants, 3 Noctuid moths (Bugong: *Agrotis spina*), 3 large Anisopterid Dragonflies, 1 Anisopterid nymph, large quantity of Algae.

A NEW XIPHOSURAN FROM THE TRIASSIC SEDIMENTS AT BROOKVALE, NEW SOUTH WALES.

By E. F. Riek.

Commonwealth Scientific and Industrial Research Organization—Division of Entomology, Canberra, A.C.T.

(Plate xiii.)

Amongst the many interesting fossils obtained from the shale beds at Brookvale is an almost complete specimen of a Xiphosuran. These Brookvale sediments are generally considered to be of freshwater origin. They contain insects as well as fish, *Estheria* and *Leaia*. As Xiphosura occur in both freshwater and marine sediments this specimen throws no light on the probable nature of the sediments.

The Xiphosuran shows many interesting features, the species being considered in a new genus for which a new family is erected.

Order Xiphosura.

Family Austrolimulidae, nov.

Similar to Limulidae but with the caudal three segments of the opisthosoma distinct and not consolidated.

In the only known species the opisthosoma is not produced laterally into spines and the very large genal spines are directed laterally.

Genus **Austrolimulus,** gen. nov.

Genotype **Austrolimulus fletcheri,** sp. nov.

Differing from recent *Limulus* in the structure of the opisthosoma and less so of the prosoma. Opisthosoma divided into two regions, the anterior three segments consolidated and tapering markedly caudally, the posterior three segments distinct but anchylosed and of almost equal width; segments of the opisthosoma without lateral spines or projections, except that the caudal segment is bluntly produced postero-laterally; caudal spine longer than body; postero-lateral margins of prosoma (genal area) produced laterally into very long spines.

The genus would seem to occupy a position intermediate between Belinuridae and Limulidae as, in the former family all the segments of the opisthosoma are distinct, though often anchylosed, whereas in the latter they are all consolidated.

Austrolimulus fletcheri, sp. nov.

The specimen is preserved as external and internal moulds of the dorsal surfaces of the prosoma and anterior three segments of the opisthosoma and as ventral views and moulds of the ventral surface of the caudal three segments of the opisthosoma, caudal spine and the "free cheeks" which are produced into long, laterally directed genal spines.

Prosoma wider than long (excluding the genal spines); dorsal surface not clearly preserved, more distinct on the internal mould; divided into three subequal areas by a somewhat raised carina running slightly postero-laterally to the highest point which possibly represents the spine above the eye, and then postero-mesally to the junction of the pleural groove of the opisthosoma; eye, if correctly interpreted, at the junction of the middle and caudal thirds of the prosoma; median third of prosoma divided into narrow "glabella" region, about one-quarter of the width of this portion,

and the two "fixed cheeks"; lateral margins of the glabella irregular or lobed with apparently a median spine anteriorly; the fixed cheeks rather finely, irregularly tuberculate; free cheek divided into two regions, a narrow marginal zone which postero-laterally is produced into the very pronounced genal spine directed laterally and an inner zone between this and the fixed cheek; inner zone coarsely, irregularly tuberculate; marginal zone smooth, gradually narrowing anteriorly; genal spine all lying anterior to the caudal margin of the prosoma, its surface ornamented at base both anteriorly and posteriorly (particularly) with short irregular transverse rugae, towards apex with fine ornamentation, at least ventrally towards apex with a median longitudinal carina and dorsally towards apex apparently with a pair of finer carinae, at base with two diverging, more or less transverse carinae; caudal margin of prosoma forming a three-sided re-entrant angle; genal spine almost as long as the width of body of prosoma.

Opisthosoma divisible into two regions, an anterior region of three consolidated segments and a caudal region of three distinct segments; anterior three segments tapering markedly posteriorly; caudal three segments of about equal width; antero-lateral free lobe distinct, not extending laterally beyond the outer limit of the caudal re-entrant of the prosoma, the lobe lying in a different plane from the rest of the opisthosoma; segments of the opisthosoma without lateral spines, caudal segment bluntly pointed postero-laterally; ventral surface of caudal three segments with sutures distinct, surface convex, roughly rugulose; anterior three segments rather finely, irregularly tuberculate dorsally; central axis of opisthosoma distinct, anteriorly of similar width to the glabella but tapering over the caudal segments; pleura with a transverse sulcus at about their middle, together forming a longitudinal sulcus converging caudally; caudal three segments together a little shorter than the anterior three.

Telson drawn out into a long caudal spine; spine at least one and a half times the length of body, distinctly longer than prosoma is wide (excluding genal spines); spine triangular in section, apparently similar to that in recent *Limulus*.

Size.—Length, including caudal spine, 5¾ inches; prosoma plus opisthosoma 2¾ inches; width including genal spines 7 inches; genal spine 2¼ inches.

Type.—Holotype F.38274, and counterpart F.38275, in the Australian Museum, Sydney.

Type Locality and Horizon.—Beacon Hill shales about mid-way in the Hawkesbury Series, Middle Triassic, at Brookvale, near Sydney, New South Wales.

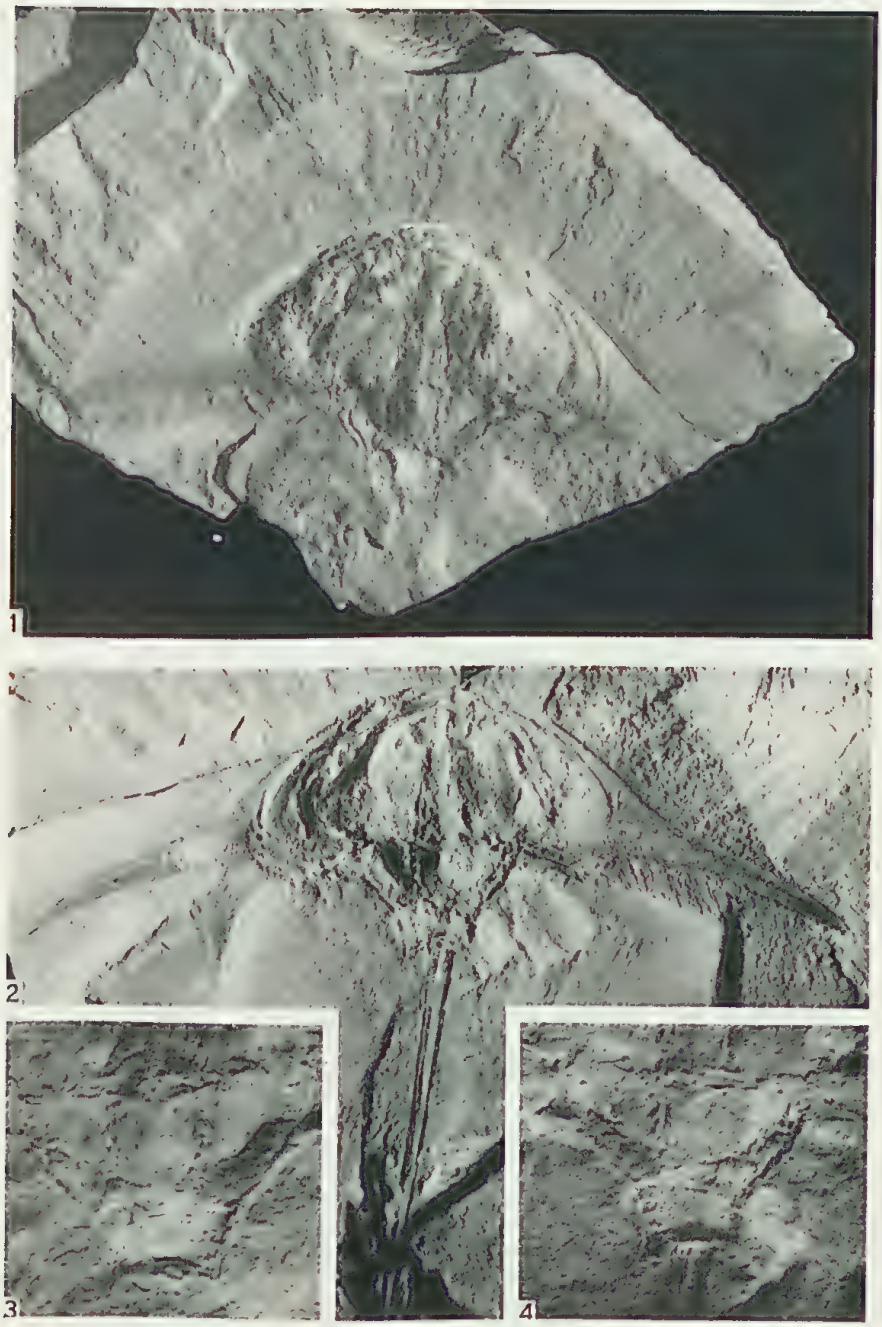
Only the holotype specimen is known.

This most interesting species is named for Mr. H. O. Fletcher, paleontologist at the Australian Museum, who has always been most helpful to the author in his studies on fossil arthropods. The figures of the plate were prepared by Mr. Howard Hughes of the Australian Museum, who continues to do excellent work in this field.

Explanation of Plate XIII.

Figures 1-4.—*Austrolimulus fletcheri*, gen. et sp. nov.

1. Counterpart of holotype x ½.
2. Holotype x ½.
3. Opisthosoma of counterpart showing the segmentation of the caudal segments (reversed lighting). x slightly more than 2/3.
4. Opisthosoma of holotype showing the segmentation of the caudal segments. x slightly more than 2/3.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HERPETOLOGICAL NOTES No. 5.

By J. R. Kinghorn.

(Plate xiv; two Text-figures.)

1. Taxonomic Changes in the Genus Rhynchoelaps.

Recent investigation shows that *Rhynchoelaps bertholdi* belongs to an entirely different genus of snakes from other species generally placed in the same genus.

R. bertholdi has what may be described as typical elapine type head scalation, whilst other members of the group have a shovel-shaped snout, with a more or less oblique arrangement of head shields, naturally conforming to the disposition of the bones of the skull.

Only one member of the shovel-snouted group has a more or less normal type arrangement of shields, but it is quite distinct from *bertholdi*. This species is *fasciolata*, originally named *Rhinelaps fasciolatus* Gunther, but in this the nasal is widely separated from the preocular:

Jan, in *Rev. et Mag. Zool.*, p. 518, Dec. 1858, first mentioned *E. bertholdi* with *Rhynchoelaps* proposed as a subgenus, but there was no description. In the same magazine, 1859, 2, ii, p. 123 he uses the name *Simoselaps*, genotype *E. bertholdi* and gave a fairly full description; so it would appear that *Simoselaps* should be used; but because of common usage I propose at present to refer it to *Rhynchoelaps bertholdi*.

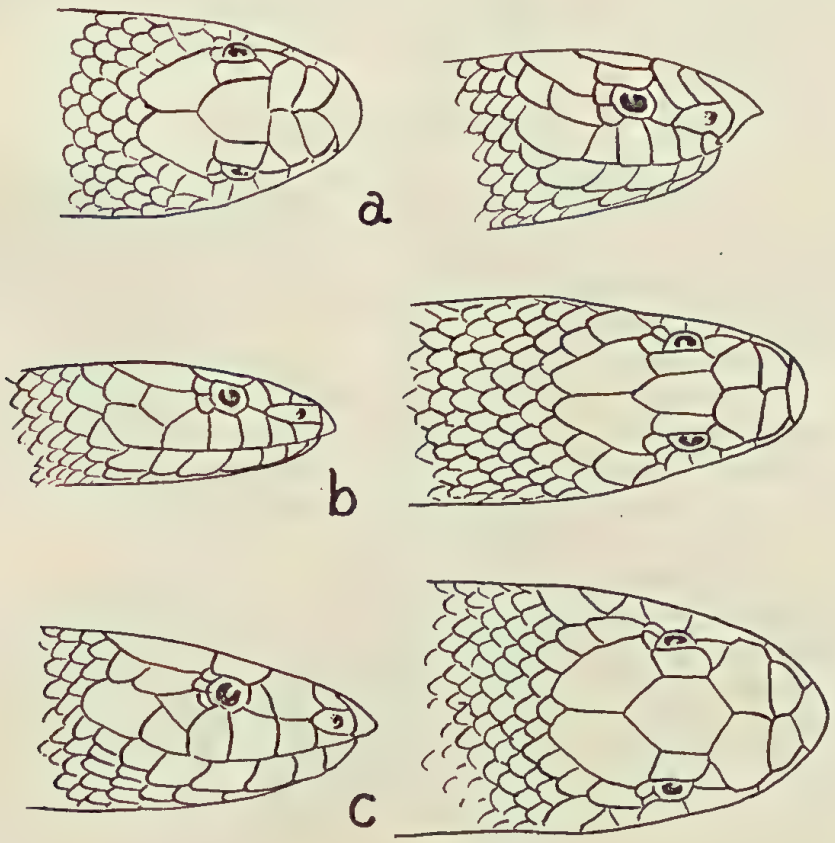


Figure 1.

a—*Brachyurophis australis* Krefft. *b*—*Rhynchoelaps bertholdi* Jan. *c*—*Rhinelaps fasciolatus* Gunther.

Magnification approx. x 4.

In 1863, Gunther, *Ann. Mag. Nat. Hist.* 3, XI, p. 21, Pl. iii, fig. B, described *Brachyurophis semifasciatus,* a species which has an extraordinary oblique type of head shield common to several other species. These snakes are at present being thoroughly reviewed and types examined before full report can be made. In the meantime this notification of change of nomenclature is made, pending the publication of a comprehensive, but more or less popular book on the Australian snakes, in which the amended names will be used. It is proposed that the following names should now be used:

Rhynchoelaps bertholdi Jan.
Rhinelaps fasciolatus Gunther.
Rhinelaps approximans Glauert.
Brachyurophis australis Krefft.
„ *semifasciolatus* Gunther.
„ *roperi* Kinghorn.
„ *campbelli* Kinghorn.
„ *wood-jonesi* Thompson.

2. The Presence of a Post-Frontal Bone in Furina.

It has always been accepted that one of the distinguishing characters of the genus *Furina* was the absence of the post-frontal bone, this being recorded as one of the main differences between *Furina* and its nearest affinities.

During a recent examination of a skull treated and stained with alizarin, a very small and triangular post-frontal was found intact.

Without staining the skull, which is a fairly recent method of preparation for examination, this bone may be missed, and even with the most careful dissection it comes away with the integument; hence the general acceptance of its absence as recorded in literature.

3. A New Generic Name for Two Nominal Species of *Pseudechis.*

For more than thirty years, continued efforts to locate the type of *Pseudechis ferox* (*Diemenia ferox* Macleay) have failed, and it may now be declared lost or inadvertently destroyed. Because of this it has been found necessary to rely on published descriptions and notes, and a critical examination of these indicates a very close affinity between *ferox* and *microlepidotus.*

The slight difference in colour between these is of no specific importance, whilst in regard to scalation, *ferox* was described as having a divided and *microlepidotus* a single anal scale; also considered by me in this instance, of no vital importance, because of the possibility of error or abnormality. I therefore propose to regard *P. ferox* as synonymous with *P. microlepidotus,* and submit the following to show that this snake must be placed in a new genus.

During a close examination of the types it became fairly obvious to me that certain characteristics indicated some small degree of affinity with three genera, viz., *Oxyuranus, Pseudechis* and *Demansia,* but because of a certain group of characters *microlepidotus* cannot rightly be classified as belonging to any of these.

Macleay indicated that he placed *ferox* in the genus *Diemenia* rather against his inclination. The presence of three small maxillary teeth following the fang might suggest an affinity with *Pseudechis,* and the paired subcaudals suggest *Demansia,* but no species of this genus has fewer than six maxillary teeth, and certainly not only three. The twenty-three rows of scales round the body might suggest *Oxyuranus,* but they are smooth whereas those of *Oxyuranus* are decidedly keeled; furthermore the anterior portion of the palatine is not prolonged and needle-like as in *Oxyuranus,* but even though slightly produced may be regarded as a normal type and on a level with the front edge of the maxillaries.

So with a normal type of palatine-maxillary relationship; 23 rows of scales which are smooth; 2-3 temporals, a single anal and paired subcaudals, a new generic name is suggested.

Parademansia, gen. nov.

Definition—Three small maxillary teeth behind the fang. Anal single, subcaudals paired. Anterior portion of the palatine normal, and extending forward to the level of the front edge of the maxillary bones. Scales smooth, in 23 rows.

Genotype, *Pseudechis microlepidotus* McCoy.

Parademansia microlepidotus (McCoy).

Fig. 2.

Diemenia microlepidota McCoy, *Prod. Zool. Vict.*, 1, (3) 1879, p. 12, Pl. 23, figs. 2-3.

Diemenia ferox Macl., *Proc. Linn. Soc. N.S.W.*, vi, 1882, p. 812.

Description.—Snout broadly rounded, pupil round. Rostral broader than deep, visible from above. Internasals half as long as the prefrontals, not in contact with the preocular. Frontal broader than the supraocular, once and one-half as long as broad, as long as its distance from the rostral, and about two-thirds the length of the parietal. Nasal divided, in contact with the single preocular. Two postoculars, six upper labials, the third and fourth entering the orbit. There are 23 rows of smooth scales round the middle of the body and from 30 to 36 round the neck. Ventrals 230-237, anal single, subcaudals all divided, in 61-66 pairs. The anterior chin-shields in contact with three lower labials.

Colour.—Brown to blackish above, and creamy to white underneath.

Length.—The species grows to about seven feet. Two specimens of *microlepidotus* were examined; one measured four feet nine inches and the other six feet one inch.

Type, R. 12870 in the National Museum, Melbourne.

Co-type R. 12871, in the same collection.

Localities.—The junction of the Murray and Darling Rivers. Type of *ferox* (lost): Fort Bourke, N.S.W.

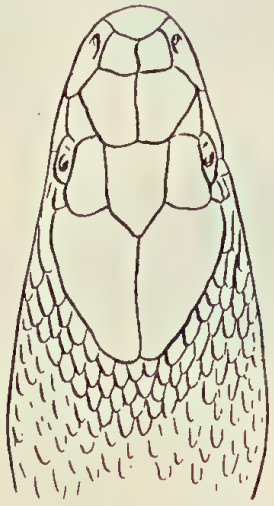


Figure 2.

Parademansia microlepidotus McCoy. From the type in the National Museum, Melbourne. Magnification approx. x 1½.

4. A New Species of *Egernia* from Queensland.

Egernia hosmeri, sp. nov.

(Plate xiv.)

Description.—Head small, depressed, triangular, measured across the nuchals as broad as long. Head shields rugose, some with strongly denticulated posterior borders, thereby giving the appearance of being imbricate. Ear opening larger than the eye, almost hidden under the large anterior spinose scales. There is a groove behind the nostril which is in a long undivided nasal.

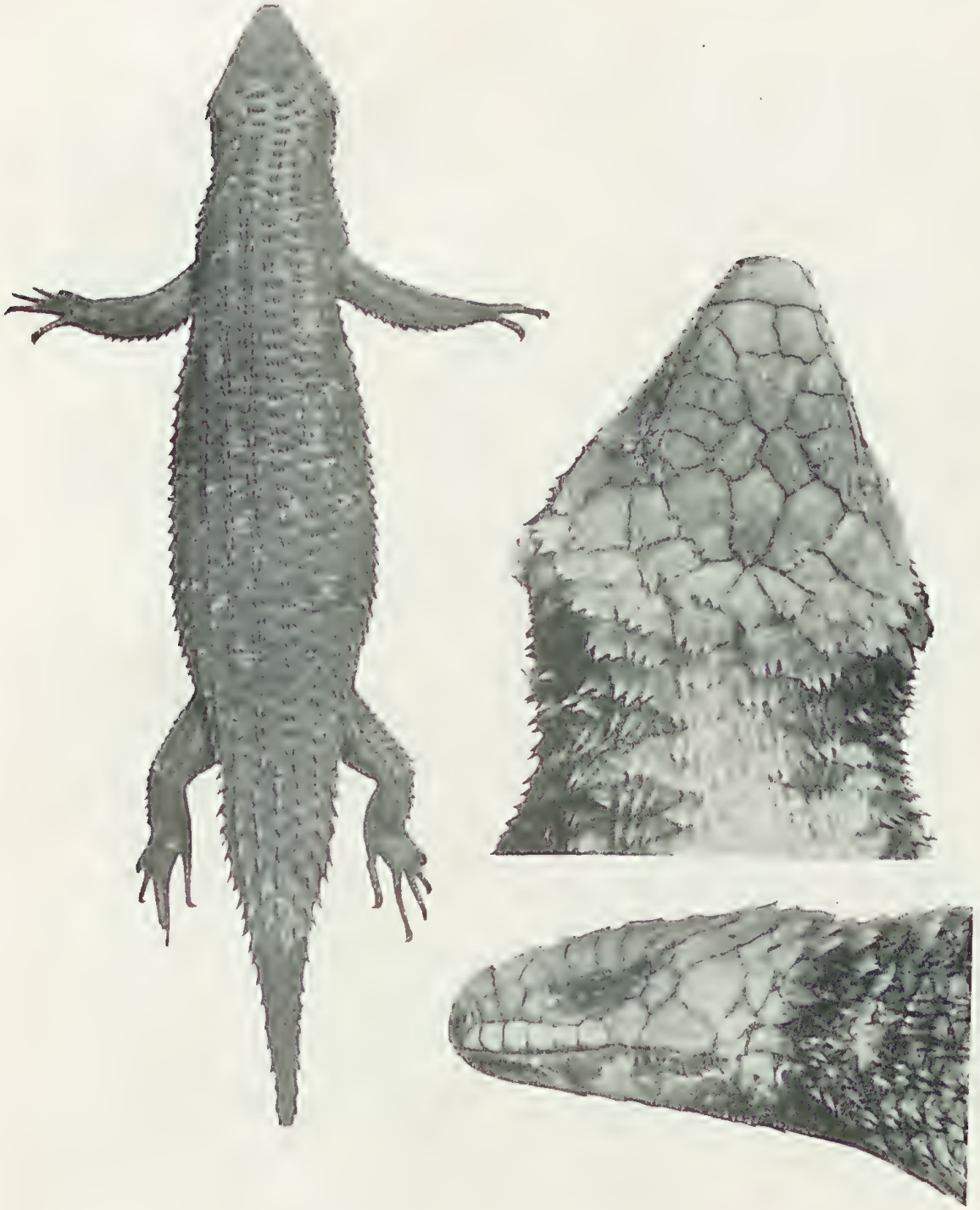
The prefrontals form a medium suture and they are larger than the frontoparietals. Frontal broader but not longer than the interparietal, and smaller than the parietals. Frontonasal in contact with the rostral. Five supraoculars, the second being the largest, the posterior one being small and inconspicuous. Seven or eight supraciliaries; eight upper labials, the sixth and seventh under the eye. There are 26 scales round the body, the dorsals being strongly spinose. Two rows of nuchals are mostly tri-spinose, though some are quadri-spinose. The posterior border of the nuchals, being free, and apparently partially erectile, form a fringe or collar from ear to ear. The central dorsal scales carry three spines, though a few may have four. The laterals are also fairly strongly bi-spinose. The free portion of the spines on the dorsals is about half as long as the scale. The tail is cylindrical, though slightly depressed at the base, each scale with a long spine. Limbs small but sturdy, and when adpressed barely meet. There are fifteen lamellae under the fourth toe.

Colour in Spirits.—Brownish above with a few scattered darker brown scales. The abdomen is immaculate and whitish; a few dark mottlings under the chin and throat.

Holotype, No. R. 12947 in the Australian Museum collection; from Kaban, Queensland, collected by Capt. R. V. Southcott, Sept. 1945. Total length 245 mm., the tail 80 mm., tip missing.

Co-types.—R. 14377 from Alappa Junction near Chillago, Q'ld., collected by W. Hosmer. Total length 255 mm., tail 95 mm. R. 14378 from Petford, North Q'ld., collected by R. Robichaux, 28th Dec., 1953. Total length 192 mm., tail 82 mm.

Affinities.—*E. hosmeri* is most nearly related to *E. cunninghami,* but *cunninghami* has 36-42 scales round the body. The adpressed limbs overlap and the dorsal scales have a single keel. In *E. stokesii* there are 32-34 body scales, and the tail is flattened and more spiny than in *hosmeri.*



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